Grants Reclamation Project
2015 San Andres Well Integrity Testing

For:

Homestake Mining Company
P. O. Box 98
Grants, New Mexico 87020

By:

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December 2015

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Executive Summary

Well integrity testing is being conducted by Homestake Mining Company of California (HMC) on HMC San Andres wells that are located on the Grants Reclamation Project (GRP). The schedule for this testing program was approved by the New Mexico Environment Department (NMED) on 6 July 2015. While other wells will be tested and evaluated at a future date, this particular report presents the results of the well integrity testing of San Andres wells 951, 928 and Old #1. Subsequent reports will be sent to the regulatory agencies as the testing of additional San Andres wells is completed.

Geophysical logging and a video camera were used to evaluate the three aforementioned wells. The report also presents water quality results from monitoring of the four San Andres wells that are being used to supply fresh water for the ground-water restoration program.

- The San Andres well integrity testing for well 951 shows that the integrity of this well is good and the well is suitable for use as a monitoring well for the San Andres aquifer.

- The testing of well 928 indicates that alluvial water is entering into the well through the well's casing. However, it should be duly noted that the water level and current depth of the well indicate that the well is functioning as a Middle Chinle aquifer well and is not connected to the San Andres aquifer. Therefore, there is little concern for the compromised casing to adversely affect the San Andres aquifer. HMC proposes to develop an abandonment plan for well 928, gain concurrence from NMED on this plan, and within 90 days of obtaining such concurrence, will submit said plan to the New Mexico Office of the State Engineer (NMOSE) for final approval. After final approval of the abandonment plan from NMOSE, well 928 will be abandoned within one year.

- The testing of well Old #1 shows that the water level in this well is representative of the alluvial or Upper Chinle aquifer, and this may indicate the existence of a plug that seals off the San Andres in this well. Additional testing will be required to determine if a plug exists in well Old #1, after which point, a final abandonment plan can be developed for this well. This additional testing can be done within 90 days after reaching concurrence with the NMED.

- The water quality in existing San Andres supply wells #1, #2, 943 and 951R is unchanged in 2015 and this indicates that well integrity in these wells has not changed. The increase in 2014 and decline in 2015 in uranium concentrations in well 951R is not a function of pumping from this well, because it has been continuously pumped over this entire period. Therefore, these four San Andres wells can continue to be used as a fresh water supply. Well integrity testing for these four wells is planned for 2016.

1.0 Introduction

This report presents the results from the integrity testing of Homestake Mining Company of California's (HMC) San Andres wells 951, 928 and Old #1. These three San Andres wells are located on the Homestake Grants Reclamation Project. HMC's DP-200 required testing in the fourth quarter of 2015 to evaluate the integrity of HMC's San Andres wells, 951, 928 and Old #1.

San Andres well 951 was used for a supply for fresh water from 1999 through 2012 for the North Off-Site area and presently is being used by the Department of Energy (DOE) for monitoring at the Bluewater tailings site. Well 928 is an old irrigation supply well that exists upgradient from the HMC site, and was used for irrigation of the area *prior* to the uranium mill's operation. Well Old #1 was used as a supply well for the mill prior to being replaced by the Deep #1 well in 1979.

Figure 1-1

Location of San Andres Wells and Water Quality Data for San Andres Aquifer
2015, mg/l

5160′ 923

860 | 0.303
0.009 | 2110

1120′ 928

WEST FAULT

EAST FAULT

360 | 0.032
0.006 | 950

951

COUNTY ROAD 63

951R

582 | 0.032
0.009 | 1490

LARGE-TAILINGS-PILE
(RECLAMATION IN PROGRESS)

705 | 0.012
0.008 | 1800

HMC OFFICE

OLD #1

#1

739 | 0.007
<0.005 | 1950

HIGHWAY-605

COLLECTION POND

LINED EVAP POND NO. 2

#2

LINED EVAP. POND #1

SMALL TAILINGS PILE

PLEASANT-VALLEY ESTATES

638 | 0.029
0.009 | 1870

806R

MURRAY-ACRES

VALLE VERDE

949

991

987

986

955

822

BROADVIEW ACRES

741 | 0.028
0.024 | 1730

943

FELICE-ACRES

THUNDERBIRD LANE

545 OO 995

COUNTY ROAD 25

938

RAILROAD

HIGHWAY-122

WEST FAULT

911

907

998

395 | 0.012
0.014 | 927

188 | 0.004
0.009 | 527

140 | 0.004
0.007 | 463

RALPH CARD ROAD

535 1800′ 534

999 7700′

532 13000′

1545500
1543500
1541500
1539500
1537500
1535500
1533500

473400 475400 477400 479400 481400 485400 487400 489400 491400

N
W E
S

NOTE: DATA FOR WELLS 532, 999, 806 AND 998 IS 2014 DATA.

--LEGEND--

- SAN ANDRES WELL
- 943 FRESH-WATER INJECTION SUPPLY WELL
- 1050′ OFFSET WELL

SO4 | U
Se | TDS

SUBCROP OF SAN ANDRES ALLUVIUM OVERLIES LIMESTONE

SCALE: 1" = 1600'	
C:\PROJECTS\2015-06\1600SAN bmw	
DATE: 3/13/2015	

FIGURE 1-1. LOCATION OF SAN ANDRES WELLS AND WATER QUALITY DATA FOR THE SAN ANDRES AQUIFER 2015, mg/l

2.0 San Andres Well Integrity

The integrity of San Andres wells 951, 928 and Old #1 were evaluated in the fourth quarter of 2015. A video of the wells and geophysical logs were done by Jet West Geophysical Services to assess the integrity of these three San Andres wells. Jet West Geophysical Services also provided interpretation of the logs included in the following discussion.

A gamma ray log was used to define the lithology. Gamma curves can be affected by the fill material in a well's annulus, and thus may indicate changes in completion materials. A 3-arm caliper log measures the inside diameter of a well's casing and indicates where scaling or corrosion/erosion may be present.

The sonic-cement bond log (CBL) is composed of four curves: near receiver (3-foot) variable density log (VDL), near first arrival, delta time, and amplitude. The tool consists of a sonic transmitter which emits a 20 kHz sound pulse twice every second, and two receivers which record the degraded sound energy at a distance of 3 and 4 feet. The tool requires fluid in the well to convey the sound energy. The near, or 3-foot, receiver VDL curve is presented in the log, and the last three curves are derived from the VDL curve. Near first arrival is a measure of the initial compressional energy (in micro-seconds of time) from the tool's transmitter to the receiver spaced 3 feet up the tool. Amplitude represents the signal height of the near first arrival and is read qualitatively. High amplitude readings indicate "ringing" steel pipe and lower amplitudes indicate attenuated sound energy or bonded pipe. Delta time is a measurement of "slowness" in micro-seconds per foot (μsec/ft). Slowness is the inverse of velocity (ft/sec). The velocity of sound travelling through steel is approximately 17,500 ft/sec which equates into a slowness of 57 μsec/ft. Slowness is calculated by subtracting the first arrival of the 3-foot receiver from that of the 4-foot receiver.

The 4 Pi log is read qualitatively in a reverse fashion from higher to lower counts with the higher counts indicating lower density materials.

2.1 Well 951

Well 951 is presently being used to monitor the San Andres aquifer approximately three miles west of the HMC tailings impoundment. The well was logged from the top to a depth of 220 feet with video camera, gamma ray, 3-arm caliper, sonic, and 4 Pi density.

2.1.1 951 Lithology and Well Completion

Well 951 was drilled in 1957 and cased with 10 inch steel casing to a depth of 242 feet. The annulus of the well was cemented from 212 to 241 feet with the cement plug being drilled out after 80 hours. This well has an open hole completion from 242 to 272 feet. The water level in well 951 is representative of the San Andres aquifer and is approximately 40 feet lower than the expected water level for the alluvial aquifer at this location. Figure 2-1 presents the well completion details and the lithology for well 951 which indicates the top of the San Andres aquifer is at a depth of 242 feet below the land surface.

2.1.2 951 Geophysical Logs

Gamma ray, caliper, amplitude, delta time and, 4 Pi density logs were ran on well 951 on September 10, 2015 to evaluate the integrity of this well (see Figure 2-2). The gamma log indicates less permeable material between 97 and 142 feet, which generally corresponds to the clay and shale interval on the lithologic log. The caliper log was ran on an enhanced scale of 8-13 inches, and shows that the casing inside diameter (ID) is 10 inches with the 189 to 220 foot interval showing a large amount of scaling on the inside of the casing.

From fluid level at 154 feet to 190 feet the VDL shows little deformation. The "railroad track" signature is indicative of free pipe. There is some degradation of the VDL on the leading edge. This is believed to be due to the presence of scale/rust on the pipe surface. High amplitude and a delta time of approximately 57 µsec/ft are indicative of free pipe.

From 190 feet to total depth (TD) of the log, there is deformation of the VDL and lower amplitude readings in places, but the delta time reading is still approximately 57 µsec/ft. There may be some bonding but it is possible the sonic wave is being affected by the increased scale build-up from 189 feet to TD.

The sonic logs indicate a short interval between 190 and 196 feet that could be bonded cement in the annulus but this interval is above the top of the completion cemented zone between 212 and 241. The large amount of scaling on the inside of the casing is likely affecting the logs in this interval.

The density log shows little deflection, which is indicative of homogeneous annular fill materials absent of any voids. The increase near the bottom of the log could be a result of entering the cemented interval.

2.1.3 951 Video

A video of the 951 well was conducted on September 10, 2015 and is presented in Appendix A with the video of the other two wells. The video of well 951 above the water down to 154 feet shows no sign of water from the alluvial aquifer entering the casing. The base of the alluvial aquifer is at approximately 110 feet from the surface. The video above the water level shows some scaling, but like the caliper log, it shows significantly more scaling below 189 feet. At 202 feet the fluid becomes murkier.

2.1.4 Summary of Well 951 Integrity Testing

The geophysical logs and video for well 951 demonstrate that this well casing integrity is good. Well 951 is acceptable to continue to be used as a sampling point for the San Andres aquifer at this location.

2.2 Well 928

Well 928 is not being used by HMC and was installed and used for irrigation in this area prior to the start of Homestake's milling operations on the Grants property.

2.2.1 928 Lithology and Well Completion

Well 928 was drilled in 1945 and cased with 20 inch steel casing. This well is listed in Gordon (1961) to be completed to a depth of 865 feet into the San Andres limestone. The annulus of this well was likely not cemented and has an open hole completion. Figure 2-3 presents a hand written lithologic log for well 928 which indicates the top of the San Andres aquifer is at a depth of 801 feet below the land surface.

2.2.2 928 Geophysical Logs

Gamma ray, caliper, amplitude, delta time, and 4 Pi density logs were ran on well 928 on September 10, 2015 to evaluate the integrity of this well. A gamma log, as well as a neutron log, which were performed on this well in 1994 were not very useful in defining the shale/sandstone sequence in the Chinle formation, and this is attributed to reduced log quality or resolution in the large diameter well.

The Upper Chinle sandstone is thought to exist just below the alluvium in this area, while the top of the Middle Chinle sandstone is shown near the bottom of the logs. The caliper log shows that the casing ID is 20 inches with a large amount of scaling on the inside of the casing at depths below 67 feet.

The VDL is represented by color bands indicating sound energy in the solid and liquid regime of the borehole. The blue and red bands represent the solid steel pipe, annular fill material, and the formation. The yellow and black bands represent the water in the well (noting that sound travels faster in solids than liquids). From fluid level at 134 feet to the restriction at 312 feet, the VDL shows some deformation or the absence of parallel bands referred to as "railroad tracks." This is indicative of cement bonding to the formation and casing. Low amplitude and a delta time of 100 µsec/ft are also indicative of cement bond.

Below 312 feet, in the reduced section of the well, the fast VDL and delta time reading of approximately 57 µsec/ft and high amplitude indicate a change in hole or casing configuration. This change could be a section of open hole, a smaller string of steel casing, or possibly a broken and offset casing.

The acoustic logs indicate that cement exists behind the casing, but the large amount of scaling on the inside of the casing is likely affecting the logs and giving a false indication of bonded cement in the annulus. The density log does not show much variation in the interval logged indicating homogeneous annular fill materials absent of any voids.

2.2.3 928 Video

A video of the 928 well was conducted on September 10, 2015 and is presented in Appendix A with the video of the other two wells. The video of well 928 above the water level in the wells shows alluvial water entering the well at several intervals. This alluvial seepage starts near the alluvial water level where water is seeping through a casing seam at 43 feet. Additional water is seeping through the casing at seams at 63 and 87 feet. The seepage of water into the casing increases at 107 and 136 feet with an increase in the amount of scaling in this area as indicated by the caliper log.

2.2.4 928 Water Level and Water Quality Comparison

Since the testing indicates that the casing in well 928 is compromised, a comparison was made with water quality and water levels in overlying aquifers in the vicinity of well 928. Figures 2-5 and 2-6 present the selenium and uranium concentrations, respectively, in alluvial aquifer wells P, P1 and Q, and in San Andres well 928. Alluvial well Q is 634 feet northeast of San Andres well 928, and alluvial wells P1 and P are 1389 and 1686 feet to the southwest of well 928, respectively. As shown in Figure 2-5, the selenium concentrations in the three alluvial wells are typically several times greater than those in well 928. With the exception of a couple of anomalous measurements, there has been no significant change in selenium concentration in well 928 over the period of record. Figure 2-6 presents a comparison of uranium concentration in three alluvial aquifer wells with uranium concentration in well 928. The uranium concentration in well 928 is typically greater than that in the alluvial aquifer. In combination, Figures 2-5 and 2-6 indicate that the alluvial aquifer has no measurable impact on water quality in well 928.

A comparison was also made with the water level in well 928 and the overlying aquifers consisting of the Middle Chinle, Upper Chinle, and alluvial aquifers. The potentiometric surfaces for these aquifers are presented in the Annual Performance Report (2015). The present water level in well 928 corresponds with the potentiometric surface for the Middle Chinle aquifer. The potentiometric surface for the Upper Chinle and alluvial aquifers in the vicinity of well 928 is several tens of feet higher than the measured level in well 928. Conversely, the expected potentiometric surface in the San Andres aquifer is several tens of feet lower than that in well 928. Additionally, the well logging extended to a depth of approximately 324 feet where the well is obstructed. This TD coincides roughly with the expected Middle Chinle aquifer depth at this location.

The completion information and the recent test results (*i.e.,* the combination of TD and water level) correspond to those of a Middle Chinle aquifer well. Thus, it is believed that well 928 is actually functioning as a Middle Chinle aquifer well, and based on the testing, the historical water quality measurements, and the well completion information, it is very unlikely that there is any significant communication with the San Andres aquifer. Further rationale for this position can be supported by the fact that the San Andres aquifer is much more transmissive than the Middle Chinle aquifer; that is to say, if there were a hydraulic connection from well 928 to the

San Andres aquifer, the water levels in well 928 would quickly drop to the potentiometric surface of the San Andres aquifer in order to reach gravitational and pressure equilibrium.

2.2.5 Summary of Well 928 Integrity Testing

The geophysical logs and video for well 928 demonstrate that the well casing in this well is damaged. Well 928 has a connection with the alluvial aquifer, which allows water to drain from the alluvium into the well. The bottom of the logged hole in well 928 extends down to the top of the Middle Chinle sandstone, with the interval from the Middle Chinle sandstone to the San Andres likely sealed artificially or by the squeezing of the Chinle Shale. Water quality data verifies that 928 is not measurably affected by the alluvial drainage in the well, and water level in well 928 indicates it is responding as a Middle Chinle aquifer well.

2.3 Well Old #1

Well Old #1 has not been used since its replacement in 1979. Deep #1 well replaced the Old #1 which is located approximately 500 feet north of Deep #1 San Andres well.

2.3.1 Old #1 Lithology and Well Completion

Well Old #1 was drilled in 1958 and was cased with 16 inch steel casing with an inside diameter of 15 inches to a depth of 902 feet. The annulus of the well was cemented from bottom to surface. This well has 87 feet of shutter screen set below the bottom of the casing. The water level in well Old #1 is representative of the alluvial aquifer in this area, and is roughly 100 feet above the San Andres aquifer water level in this area. Figure 2-5 presents the well completion details and the lithology for well Old #1, which shows the top of the San Andres aquifer is at a depth of 975 feet below the land surface. This information was presented in Gordon (1961). The lithologic log indicates a sandstone interval between 275 and 385 feet and the Upper Chinle sandstone is thought to be within this interval. A second sandstone interval between 500 and 535 feet is thought to be the Middle Chinle sandstone.

2.3.2 Old #1 Geophysical Logs

Gamma ray, caliper, amplitude, delta time, and 4 Pi density logs were ran on well Old #1 on September 10, 2015 to evaluate the integrity of this well. The gamma log indicates more permeable material between 278 and 310 feet, which generally corresponds to the Upper Chinle interval on the lithologic log. The Middle Chinle is thought to exist below the total log depth. The caliper log shows that the casing is 15 inches, and the column from 272 feet to the total log depth, indicates a large amount of scaling on the inside of the casing. The sonic log exhibited four different signatures which correlated to the gamma ray, caliper, and 4 Pi density curves.

From the fluid level at 34 feet to 191 feet the VDL shows intermittent deformation. The “railroad track” signature, which is indicative of free pipe, is seen from 70 to 80 feet and then again from 100 to 125 feet. Indication of bonding is seen from 50 to 63 feet and then again from 175 to 191 feet. The amplitude and delta time curves confirm this. The 4 Pi density changes little which indicates absence of voids.

From 191 to 272 feet the VDL curve is severely degraded. The caliper curve indicates a diameter increase, which is indicative of casing loss; the 4 Pi density curve increases in counts, which is indicative of a less dense environment and the presence of some voids (225-230 feet). Thus, there is believed to be a loss of casing in this area.

From 272 to 405 feet the VDL returns to a constant level with the yellow banding similar to the area from 34 to 191 feet, but its leading edge only contains a single blue band. Delta time and amplitude readings are indicative of bonded pipe, but it is likely these are false, because they appear to be influenced by the heavy scaling associated with the pipe in this zone. The 4 Pi density increases in counts as well, but the increase is likely due to the 1 to 3-inch build-up of scale on the pipe, so this zone is interpreted as free pipe.

The acoustic logs (amplitude and delta time) show three intervals (40 to 190 feet, 190 to 272 feet, and 272 feet to the bottom of the log) with significantly different values. The data from the 190 to 272 feet column as well as near the bottom of the log indicate cement bonded casing and/or changes in the formation may be affecting the log values. The log from 288 feet to near the bottom of the log indicates lack of cement bond since the amplitude is high. The large amount of scaling on the inside of the casing below 272 feet could be affecting the logs in this interval. From 405 feet to TD, the amplitude decreases and the caliper reads closer to the 15-inch pipe diameter, while the 4 Pi density decreases slightly and the VDL appears deformed. This may indicate some cement bond in this zone. The density log increase near the bottom of the log is believed to be a result of the probe entering the cemented interval.

2.3.3 Old #1 Video

A video of the Old #1 well was conducted on September 10, 2015 and is presented in Appendix A with the video of the other two wells. The video of well Old #1 above the waterline down to 34 feet does not show any signs of water entering the casing. This depth is near the point where the alluvium would be expected to become saturated in this area. The water was too murky to obtain any useful information below the water surface.

2.3.4 Summary of Well Old #1 Integrity Testing

The water level in well Old #1 is not representative of the San Andres aquifer. The San Andres aquifer is much more transmissive than the other aquifers in this area and it should control the water level. The water level in well Old #1 indicates it is not connected to the San Andres aquifer. This indicates that a plug may have been placed in the well. Geophysical logs for well Old #1 indicate that some of the casing probably is not bonded to the cement in the well annulus. Well Old #1 needs additional investigation prior to developing an abandonment plan. The abandonment of well Old #1 should not be a high priority because the San Andres has apparently been isolated from the overlying aquifers in this well.

Figure 2-1

Well 951 Completion Details and Lithology

12.10.20.333a

951

12.10.20.333a Fred Treas

Casing record: 16-inch surface casing; 12-inch casing, 0-245.5 ft.; 10-inch casing, 0-241 ft., cemented in hole with 20 sacks of cement at 217-241 feet. Open hole below 241 feet.

Stratigraphic unit and material	Thickness (feet)	Depth (feet)
QUATERNARY SYSTEM:		
Volcanic rock, gray to black	96	96
Cinders, clay, loose rock	8	104
Sand, gravel, red clay	6	110
TRIASSIC SYSTEM:		
Chinle formation:		
Clay (or shale), dark red	28	138
Sandy shale (conglomeratic), gray	11	149
Sandstone, light brown, hard	10	159
Shale, blue	17	176
Shale, dark red	12	188
Sandy shale, conglomerate, brown	9	197
Sandstone, reddish brown	12	209
Clay streaks, sandstone, dark red	8	217
Shale conglomerate, gray	10	227
PERMIAN SYSTEM:		
San Andres formation:		
Limestone, gray	7	234
Sandstone, yellow	3	237
Clay and rock conglomerate, yellow	5	242
Limestone, porous, light brown	30	272
Sandstone, dark gray, hard	3	275
		TD

Form WR

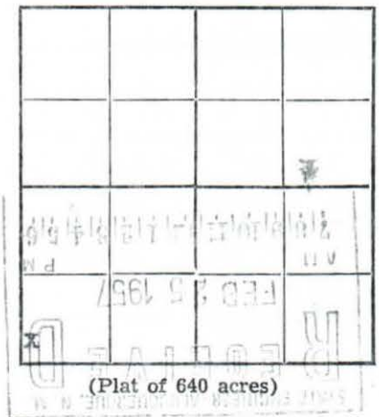
STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

951

Section 1



(Plat of 640 acres)

(A) Owner of well Sabre - Pinon Corp.

Street and Number Bokum Bldg.

City Santa Fe State New Mexico

Well was drilled under Permit No. B17-B18-B19-B20 and is located in the SW ¼ SW ¼ SW ¼ of Section 20 Twp. 12 N Rge. 10 W

(B) Drilling Contractor Howard Sheets Co. License No. W.D. 207

Street and Number 3540 Fourth St. N.W.

City Albuquerque State New Mexico

Drilling was commenced November 1956

Drilling was completed February 1 1957

Elevation at top of casing in feet above sea level ____ Total depth of well 275'

State whether well is shallow or artesian Shallow Depth to water upon completion 152'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	104'	110'	6'	Sand Gravel and Red Clay - week flow
2	138'	149'	11'	Grey Sandy Shale
3	242'	272'	30'	Light Brown Limestone - porous, This strata will produce
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
12"I.D.	1/4"Wall	Welded	surface	146'	146'	-	none	
10"I.D.	5/16Wall	Welded	surface	242'	242'	Steel	none	

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
App. 212'	241'	12"		20	Cement pumped in through tubing
					Casing lowered in cement
					Allowed to set 80 hours
					Drilled out plug

Section 5 PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____

Street and Number ____ City ____ State ____

Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____

Plugging method used ____ Date Plugged ____ 19____

Plugging approved by: 951

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received 2/25/57

File No. 1605 B-17,18,19 and 20 Use Industrial Location No. 12.10.20 333

Section 6 LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0'	96'	96'	Grey to Black	Volcanic Rock
96'	104'	8'	Dark Grey	Cinders - Clay - Loose Rock
104'	110'	6'		Sand Gravel and Red Clay
110'	138'	28'	Dark Red	Clay (or Shale)
138'	149'	11'	Grey	Sandy Shale (Conglomeratic)
149'	159'	10'	Light Brown	Sandstone, hard
159'	176'	7'	Blue	Shale
176'	188'	12'	Dark Red	Shale
188'	197'	9'	Brown	Sandy Shale Conglomerate
197'	209'	12'	Reddish Brown	Sandstone
209'	217'	8'	Dark Red	Cley - Streaks Sandstone
217'	227'	10'	Grey	Shale Congomerate
227'	234'	7'	Grey	Limestone
234'	237'	3'	Yellow	Sandstone
237'	242'	5'	Yellow	Clay and Rock Comerate
242'	272'	30'	Light Brown	Limestone, porous, (San Andres ?)
272'	275'	3'	Dark Grey	Sandstone hard (Glorieta ?)

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Howard Sheets Co
Well Driller

By Howard Sheets

Figure 2-2

Well 951 Geophysical Logs

JET WEST
GEOPHYSICAL SERVICES, LLC.

State Plane 1927
Northing:
Easting:

COMPANY Homestake Mine
WELL ID Well 951
FIELD Homestake Mine-Grants
COUNTY Cibola STATE New Mexico

TYPE OF LOG: Sonic Log

LOCATION

SEC TWP RGE

OTHER SERVICES
Video Log
3 Arm Caliper
4 Pi Density

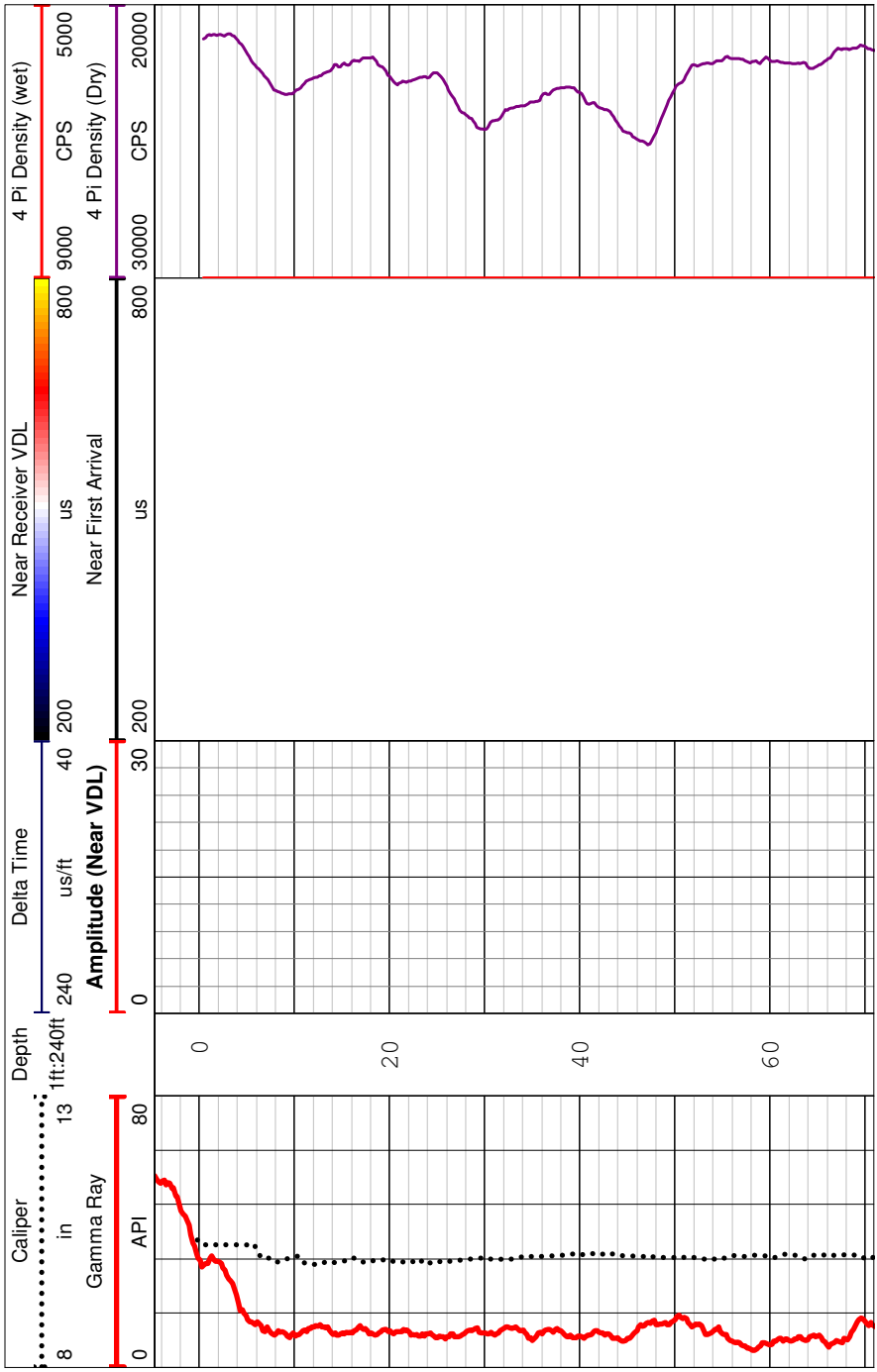
Permit No.

PERMANENT DATUM	GROUND LEVEL	ELEVATION	K.B.
LOG MEAS. FROM	Ground Level	ABOVE PERM. DATUM	T.O.C.
DRILLING MEAS. FROM	Ground Level		G.L.

DATE	9-10-2015	TYPE FLUID IN HOLE	Water
RUN No	3	SALINITY	
TYPE LOG	MSI-60mm	DENSITY	
DEPTH-DRILLER	275 ft.	LEVEL	154 ft.
DEPTH-LOGGER	220 ft.	MAX. REC. TEMP.	
BTM LOGGED INTERVAL	215 ft.	DIGITIZE INTERVAL	0.2 ft.
TOP LOGGED INTERVAL	Surface		
OPERATING RIG TIME			
RECORDED BY	A.Henderson		
WITNESSED BY	D.Kump		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1				10 in.	steel	0 ft.	275 ft.
2							
3							

REMARKS:



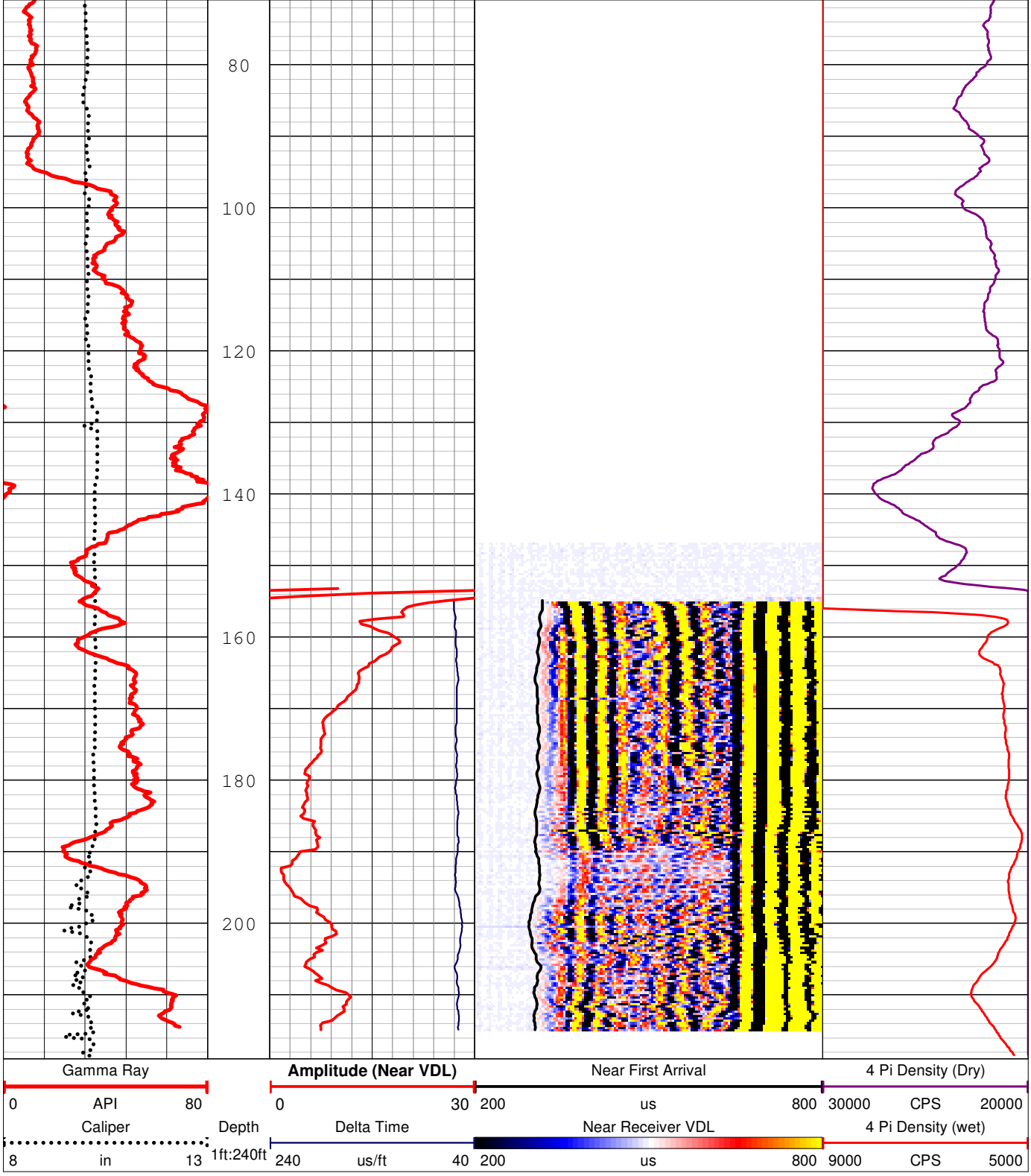

80
100
120
140
160
180
200
Gamma Ray
0
API
80
Caliper
8
in
13
Depth
1ft:240ft
Amplitude (Near VDL)
0
30
Delta Time
240
us/ft
40
Near First Arrival
200
us
800
Near Receiver VDL
200
us
800
4 Pi Density (Dry)
30000
CPS
20000
4 Pi Density (wet)
9000
CPS
5000

Figure 2-3

Well 928 Completion Details and Lithology

928

12.10.23.233

Bluewater district 12.11.25.120
223' W/L 47'
depth to aquifers 52'
with well 20' east W/L 12±
TOM ← Harmon
sched dated 5/Mar/54

Church — 2wells 12.11.25.223 + 223a ??.
Irrig.
depth 738 W/L 116.25 Feb.51
drawdown 15±

Harmon —
Van Thomas drilled Irrig. 360' deep
W/L 135
2200 gpm.
"Start in Rc
TOM ← Harmon
Mar 5-54

F. Freas 12.10.30.412 273' 103.34
1500 gpm.
TOM ← J. Freas
Mar. 5-54

Morris — 12.10.23.233
Henderson = driller
Mar 9-1954
865' W/L 126.83 Feb.51
Depth to aquifer 480'-4?
Yield 2400 gpm. Elev. 6500±
280?-240?
Psa at 801 14?Trs 210' Moenkopi.
TOM ← ATSF Agent

12.10.23.233

928

T. A. Morris + Son (old Jacobs Well)

2 x no 8 pvc

Th.	From	To	
140	0	140	— clay, sand, & gravel (quat)
71	140	211	— Rock
	211	311	— clay w/ some SS
50	311	361	SS w/ some clay) middle
320	361	681	Red Clay — & Rbks
120	681	801	& clay, white and blue, w/ a little rock
24	801	825	— Sandstone
8	825	833	— coarse loose sand Base of Aq.
32	833	865	Sandstone

6592 − 801 = 5791

6592 − 311 = 6281

6592 − 306 = 6286 neutron

T. A. Morris & Son

"OLD JACOBS" WELL

(T. A. MORRIS & SON)

2400 E

3050 N

Well No. 928

IMPORTANT — READ INSTRUCTIONS ON BACK BEFORE FILLING OUT THIS FORM.

Declaration of Owner of Underground Water Right

ROSWELL UNDERGROUND WATER BASIN

Declaration No. R-[illegible]2. Book R-1 Date received September 7, 1956

I, T. A. Morris being first duly sworn upon my oath, depose and say that the following is a full and complete statement prepared in accordance with the instructions on the reverse side of this form and submitted in evidence of ownership of a valid underground water right, that I have carefully read each and all of the items contained therein and that the same are true to the best of my knowledge and belief.

T. A. Morris declarant.

Subscribed and sworn to before me this 21st day of August A.D. 1956

My commission expires September 26, 1959 Alice Mordinoff Notary Public

STATEMENT

1. Name of water right owner T. A. Morris & Son
   of 224 Placitas NW Albuquerque
   County of Bernalillo, State of New Mexico
2. Source of water supply shallow water basin
   (state whether artesian or shallow water basin)
   located in Roswell Underground Water Basin
   (name of underground stream, valley, artesian basin, etc.)
3. The well is located in the SW ¼ SW ¼ NE ¼
   of section 23, Township 12 N, Range 10 W, N.M.P.M.
   on land owned by T. A. Morris & Son
4. Description of well: date drilled 1948 driller John Jacobs depth 284 feet.
   diameter (outside) of casing 20 inches; original flow 3000 gal. per min.;
   present flow 3000 gal. per min.; maximum pumping lift 152 feet;
   make and type of pump Peerless turbine 14" column 2-14" Bowls
   300' column of 10' section
   make, type, horsepower, etc., of power plant Buda - Diesel 275 H.P.

   Fractional or percentage interest claimed in well 100%
5. Quantity of water appropriated and beneficially used
   (feet depth or acre feet per acre)
   for irrigation purposes.
6. Acreage actually irrigated and with water right 339.7 acres,
   located and described as follows (describe only lands actually irrigated):

Subdivision	Sec.	Twp.	Range	Acres Irrigated	Owner
~~NW¼, Less NE¼, NE¼, NW¼~~	~~27~~	~~12~~	~~10~~	142.9 ✓	
~~NE¼, NW¼, NW¼~~	~~27~~	~~12~~	~~10~~	4.1	L.2
~~W½, NE¼~~	~~27~~	~~12~~	~~10~~	75.6	
~~SW¼, NW¼~~	~~27~~	~~12~~	~~10~~	36.8	
~~E½, NE¼, NE¼~~	~~27~~	~~12~~	~~10~~	19.6 ✓	
~~W½, NW¼, NW¼~~	~~27~~	~~12~~	~~10~~	15.1	
~~SE¼~~ N½ SE¼	~~27~~	~~12~~	~~10~~	17.0	
~~SW¼, NW of R-7 Irr. Ditch~~	~~27~~	~~12~~	~~10~~	14.2 ✓	
~~NE¼, NW¼~~	~~34~~	~~12~~	~~10~~	24.4 ✓	

(Note: location of well and acreage actually irrigated must be shown on plat on reverse side.)

7. Water was first applied to beneficial use 1947 and since that time has been used fully and continuously on all of the above described lands or for the above described purposes except as follows:

8. Additional statements or explanations

Figure 2-4

Well 928 Geophysical Logs

JET WEST
GEOPHYSICAL SERVICES, LLC.

State Plane 1927
Northing:
Easting:

COMPANY Homestake Mine
WELL ID Well 928
FIELD Homestake Mine-Grants
COUNTY Cibola STATE New Mexico

TYPE OF LOG: Sonic Log

LOCATION

SEC TWP RGE

OTHER SERVICES
3 Arm Caliper
Video Log
4 Pi Density

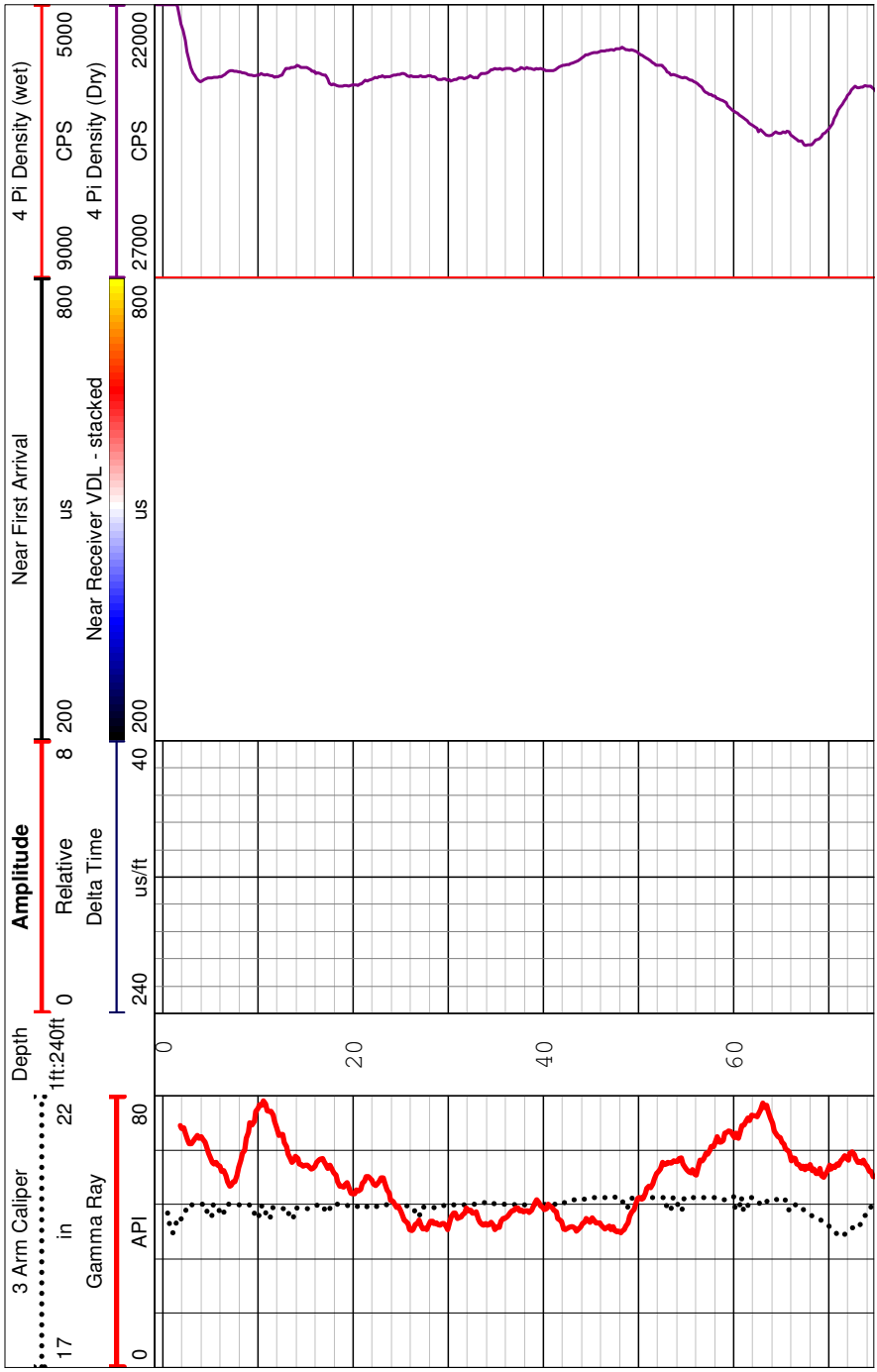
Permit No.

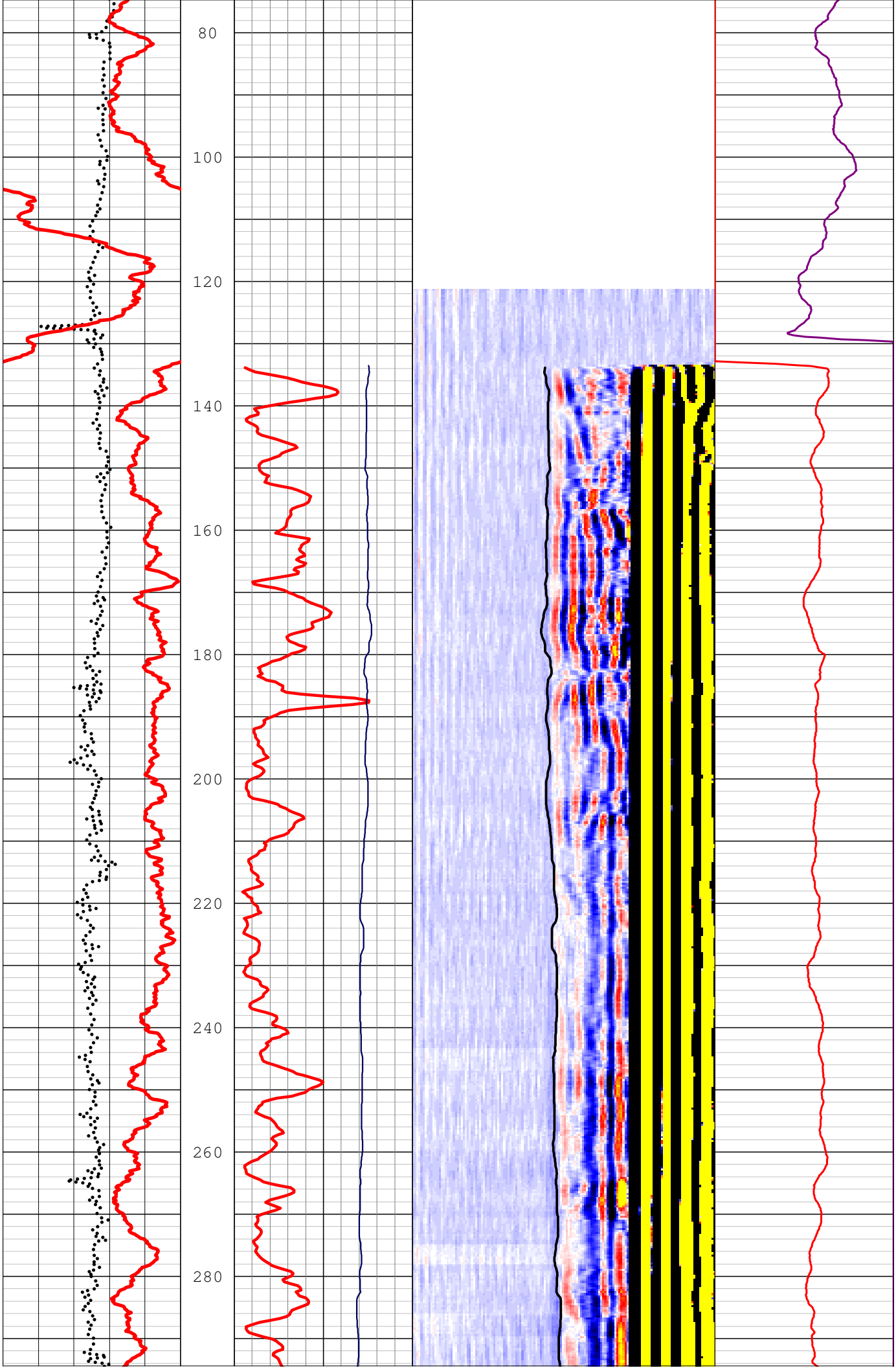
PERMANENT DATUM	GROUND LEVEL	ELEVATION	K.B.
LOG MEAS. FROM	Top of Casing	ABOVE PERM. DATUM 18 inches	T.O.C.
DRILLING MEAS. FROM	Ground Level		G.L.

DATE	9-10-2015	TYPE FLUID IN HOLE	Water
RUN No	2	SALINITY	
TYPE LOG	MSI-60mm	DENSITY	
DEPTH-DRILLER	865 ft.	LEVEL	134 ft.
DEPTH-LOGGER	325 ft.	MAX. REC. TEMP.	
BTM LOGGED INTERVAL	316 ft.	DIGITIZE INTERVAL	0.2 ft.
TOP LOGGED INTERVAL	Surface		
OPERATING RIG TIME			
RECORDED BY	A.Henderson		
WITNESSED BY	D.Kump		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1				20 in.	steel	0 ft.	928 ft.
2							
3							

REMARKS:

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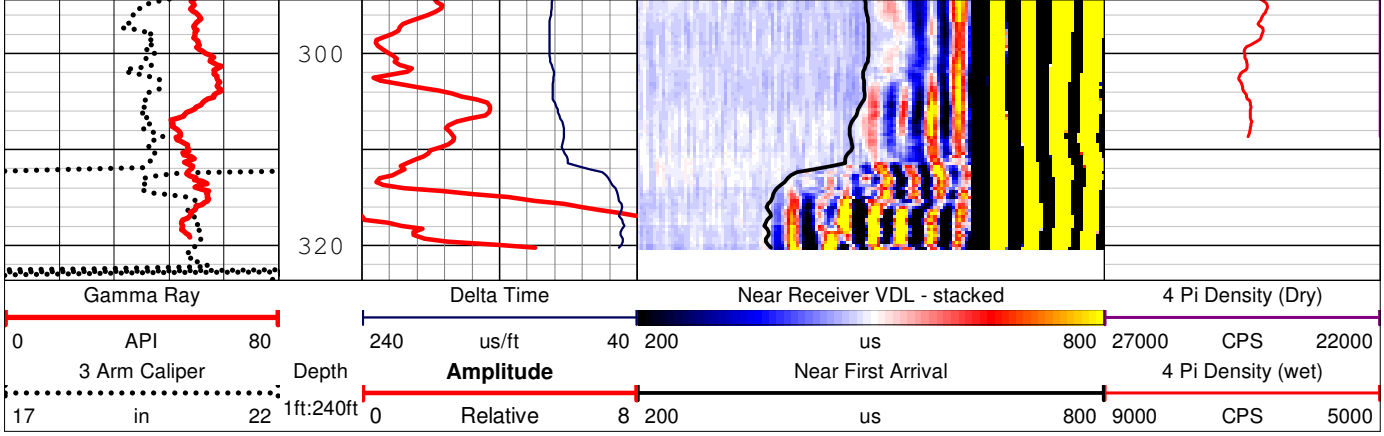
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320
Gamma Ray
0
API
80
3 Arm Caliper
17
in
22
Depth
1ft:240ft
Delta Time
240
us/ft
40
Amplitude
0
Relative
8
Near Receiver VDL - stacked
200
us
800
Near First Arrival
200
us
800
4 Pi Density (Dry)
27000
CPS
22000
4 Pi Density (wet)
9000
CPS
5000

Figure 2-5

Selenium Concentrations for Near Upgradient Wells P, P1, and Q, and San Andres Well 928

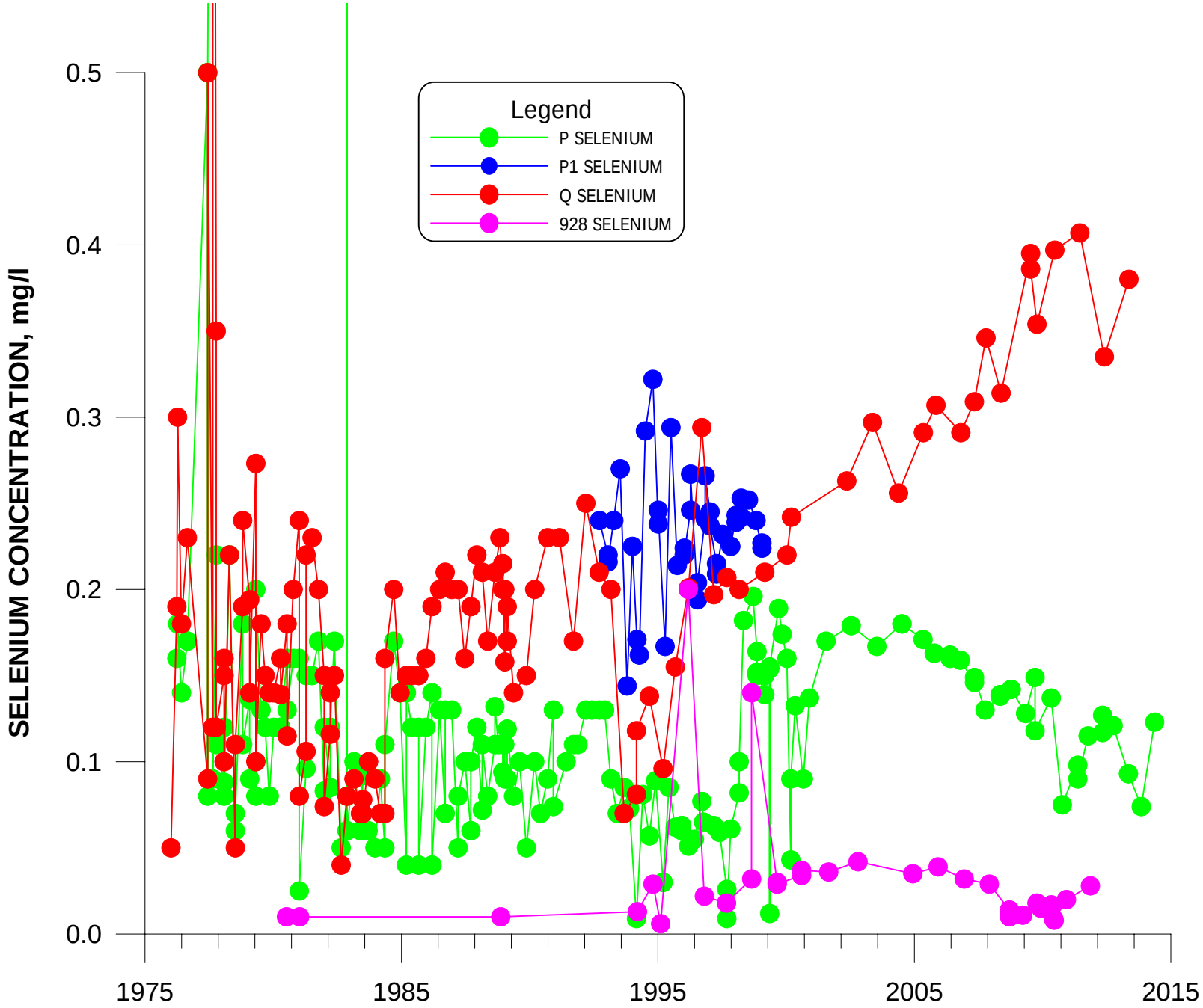


FIGURE 2-5. SELENIUM CONCENTRATIONS FOR NEAR UPGRADIENT WELLS P, P1 AND Q AND SAN ANDRES WELL 928.

Figure 2-6

Uranium Concentrations for Near Upgradient Wells P, P1, and Q, and San Andres Well 928

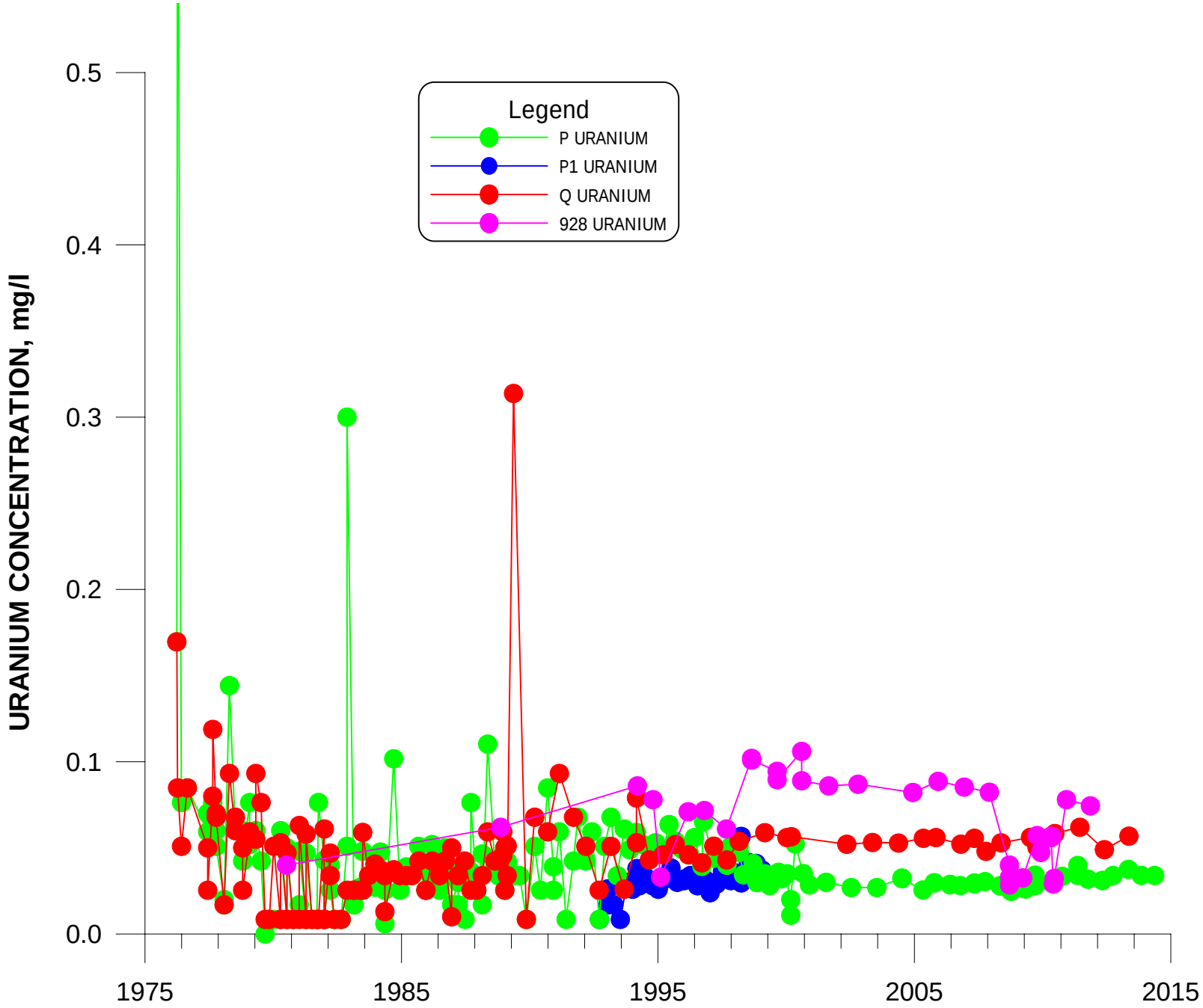


FIGURE 2-6. URANIUM CONCENTRATIONS FOR NEAR UPGRADIENT WELLS P, P1 AND Q AND SAN ANDRES WELL 928.

Figure 2-7

Well Old #1 Completion Details and Lithology

TABLE 6
LOGS OF WELLS AND TEST HOLES IN THE GRANTS-BLUEWATER AREA,
VALENCIA COUNTY, N. MEX.

(The following logs of wells and test holes were furnished by drillers, land owners, industrial companies, and other organizations. In general, the lithologic terminology is that of the persons who furnished the information. The rocks termed "malpais" in many of the logs are the same as the basalt flow rocks described elsewhere in this report. The stratigraphic correlations were made by E. D. Gordon. Many of the logs have been rearranged slightly for clarity and uniformity of presentation.)

Stratigraphic unit and material	Thickness (feet)	Depth (feet)
12.10.26.242 Homestake-Sapin Partners		OLD #1
Casing record: 902 feet of 16-inch casing, cement in place from bottom to surface. 87 feet of 12 3/4-inch shutter screen set below bottom of 16-inch casing.		
QUATERNARY SYSTEM:		
Top soil (clay, sand, and gravel)	30	30
Red clay and gravel	90	120
TRIASSIC SYSTEM:		
Chinle formation:		
Clay, red	90	210
Shale, red; traces of blue shale	5	215
Shale, red; some hard white rock	5	220
Shale, red and gray	5	225
Shale, red and blue	10	235
Shale, red and gray	5	240
Clay or shale, red	35	275
Sandstone, gray, hard	25	300
Sandstone and shale, red	85	385
Clay and sandstone, gray	10	395
Shale, clay, and sandstone	30	425
Shale and clay	15	440
Shale and limestone	5	445
Clay and sandstone	35	480
Clay and shale	15	495
Clay and sandstone	5	500
Clay		500
Sandstone, white and blue; some red clay ...	20	520
Sandstone, white; some blue clay	15	535
Clay, gray, and hard shale	35	570
Shale and sandstone	10	580
Clay and shale, gray	20	600
Shale and sandstone	45	645
Shale, sandstone, and limestone	5	650
Shale, purple, and gray sandstone	15	665
Shale and gray clay	5	670
Shale, gray, and sandstone	10	680
Shale, gray and red	40	720

TABLE 6 (continued)

Stratigraphic unit and material	Thickness (feet)	Depth (feet)
12.10.26.242 Homestake-Sapin Partners (continued)		
TRIASSIC SYSTEM (continued)		
Chinle formation (continued)		
Clay and shale, varicolored, and sandstone ...	115	835
Shale, gray and brown	5	840
Shale, purple and gray	5	845
Shale, purple, gray, and red; and red sandstone	5	850
Clay, light-red, and gray sandstone	5	855
Shale, gray, and sandstone	5	860
Shale, red and gray	20	880
Shale, gray, and sandstone	10	890
Shale, purple and gray, and sandstone	5	895
Sandstone and gray shale	5	900
Shale, purple and red, and sandstone	35	935
Shale, gray, and sandstone	25	960
Shale, gray and red, and boulders	10	970
Shale, purple, red, and gray, and sandstone ..	5	975
PERMIAN SYSTEM:		
San Andres limestone:		
Lost circulation	5	980
12.10.26.322a Homestake-New Mexico Partners		
QUATERNARY SYSTEM:		
Valley fill:		
Sand, grayish-orange, fine to coarse, rounded; chiefly frosted, quartz grains; some grayish-orange clay	10	10
Sand, grayish-orange, fine to coarse, rounded; chiefly frosted quartz	20	30
Sand, light-brown, fine to coarse, rounded; light-brown, frosted quartz	10	40
Sand, light-brown, fine to very coarse, rounded to subrounded; chiefly quartz	10	50
Sand, light-brown, fine to very coarse, 90 percent rounded to angular quartz grains; less than 10 percent light-olive-gray limestone fragments	10	60
Sand, grayish-orange, fine to very coarse, 30 percent subrounded to angular quartz; some medium to very coarse rock fragments; obsidian, and fossil fragments	10	70
Sand, grayish-orange, fine to coarse with granules, quartz 50 percent subrounded to angular quartz grains; some fossils	10	80
Sand, grayish-orange, fine to coarse with granules, 60 percent rounded to angular, frosted quartz grains; some subrounded shell fragments	10	90

Figure 2-8

Well Old #1 Geophysical Logs

JET WEST
GEOPHYSICAL SERVICES, LLC.

State Plane 1927
Northing:
Easting:

COMPANY Homestake Mine
WELL ID Old No.1
FIELD Homestake Mine-Grants
COUNTY Cibola STATE New Mexico

TYPE OF LOG: Sonic Log

LOCATION

SEC 23 TWP 10 N. RGE 1 E.

OTHER SERVICES
Video Log
3 Arm Caliper
4 Pi Density

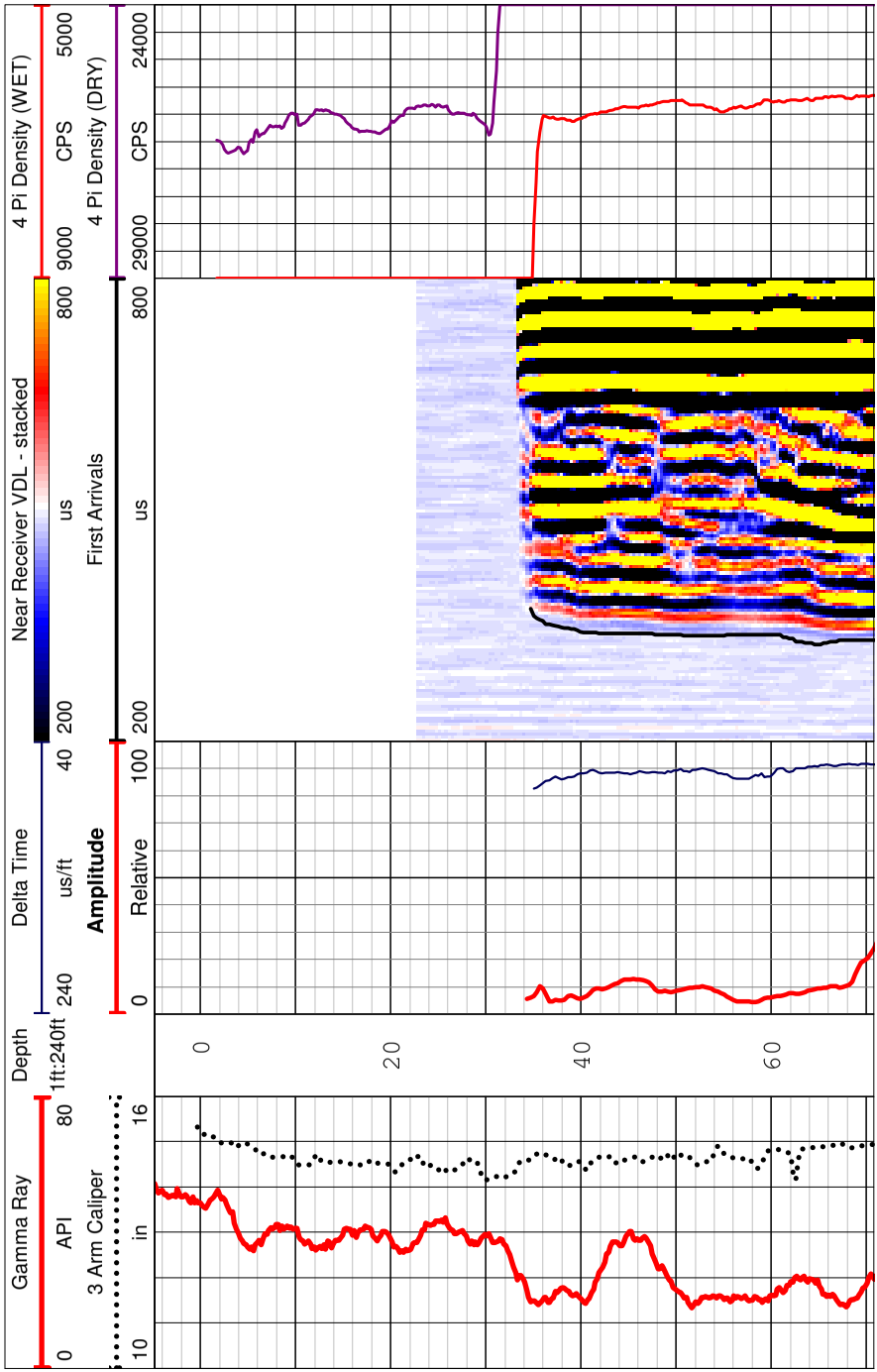
Permit No.

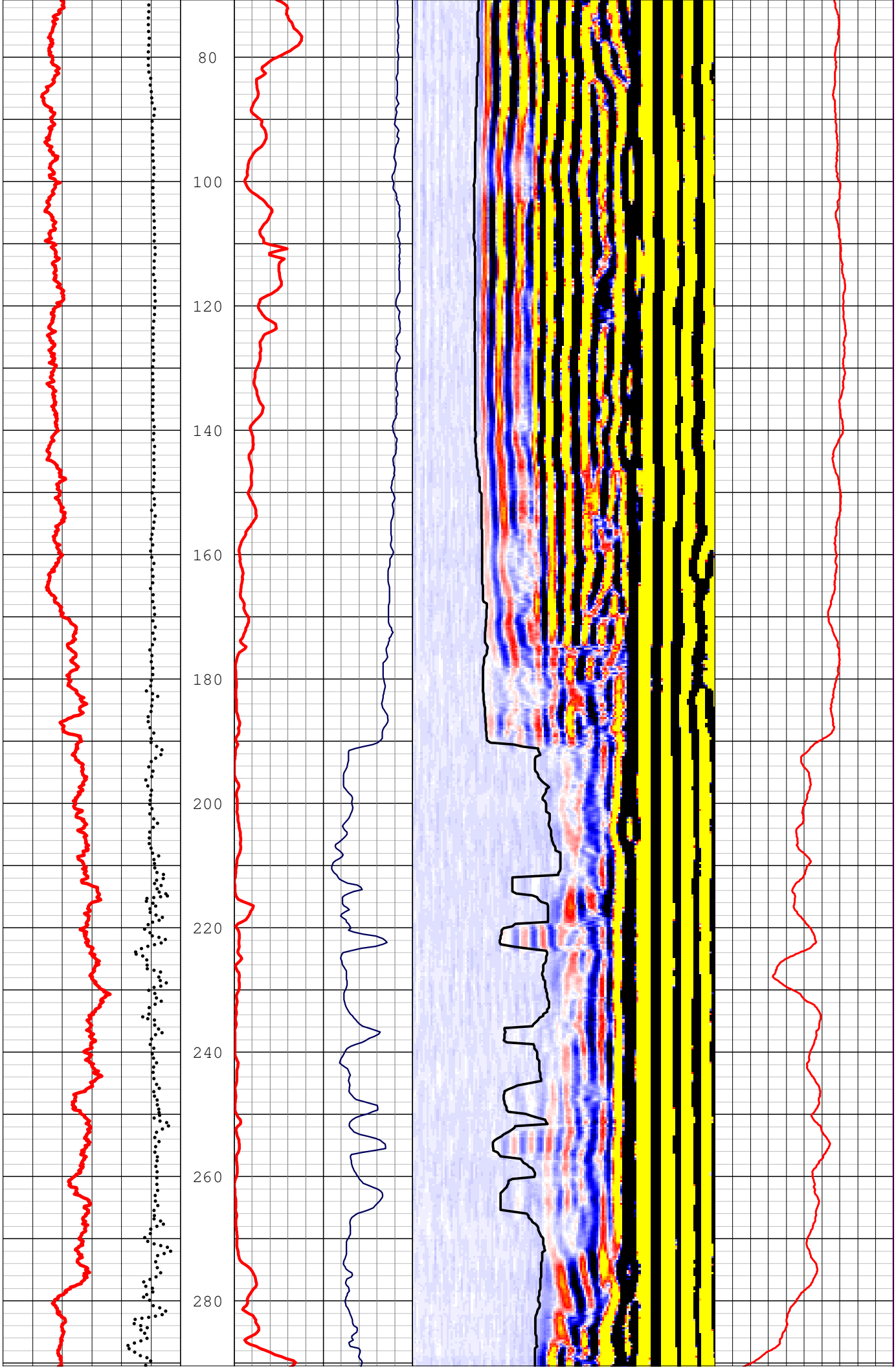
PERMANENT DATUM	GROUND LEVEL	ELEVATION	K.B.
LOG MEAS. FROM	Ground Level	ABOVE PERM. DATUM	T.O.C.
DRILLING MEAS. FROM	Ground Level		G.L.

DATE	9-10-2015	TYPE FLUID IN HOLE	water
RUN No	3	SALINITY	
TYPE LOG	60 mm	DENSITY	
DEPTH-DRILLER	980 ft.	LEVEL	54 ft.
DEPTH-LOGGER	432 ft.	MAX. REC. TEMP.	
BTM LOGGED INTERVAL	425 ft.	DIGITIZE INTERVAL	0.2 ft.
TOP LOGGED INTERVAL	Surface		
OPERATING RIG TIME			
RECORDED BY	A.Henderson		
WITNESSED BY	D.Kump		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1				16 in.	steel	0 ft.	190 ft.
2							
3							

REMARKS:

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180
200
220
240
260
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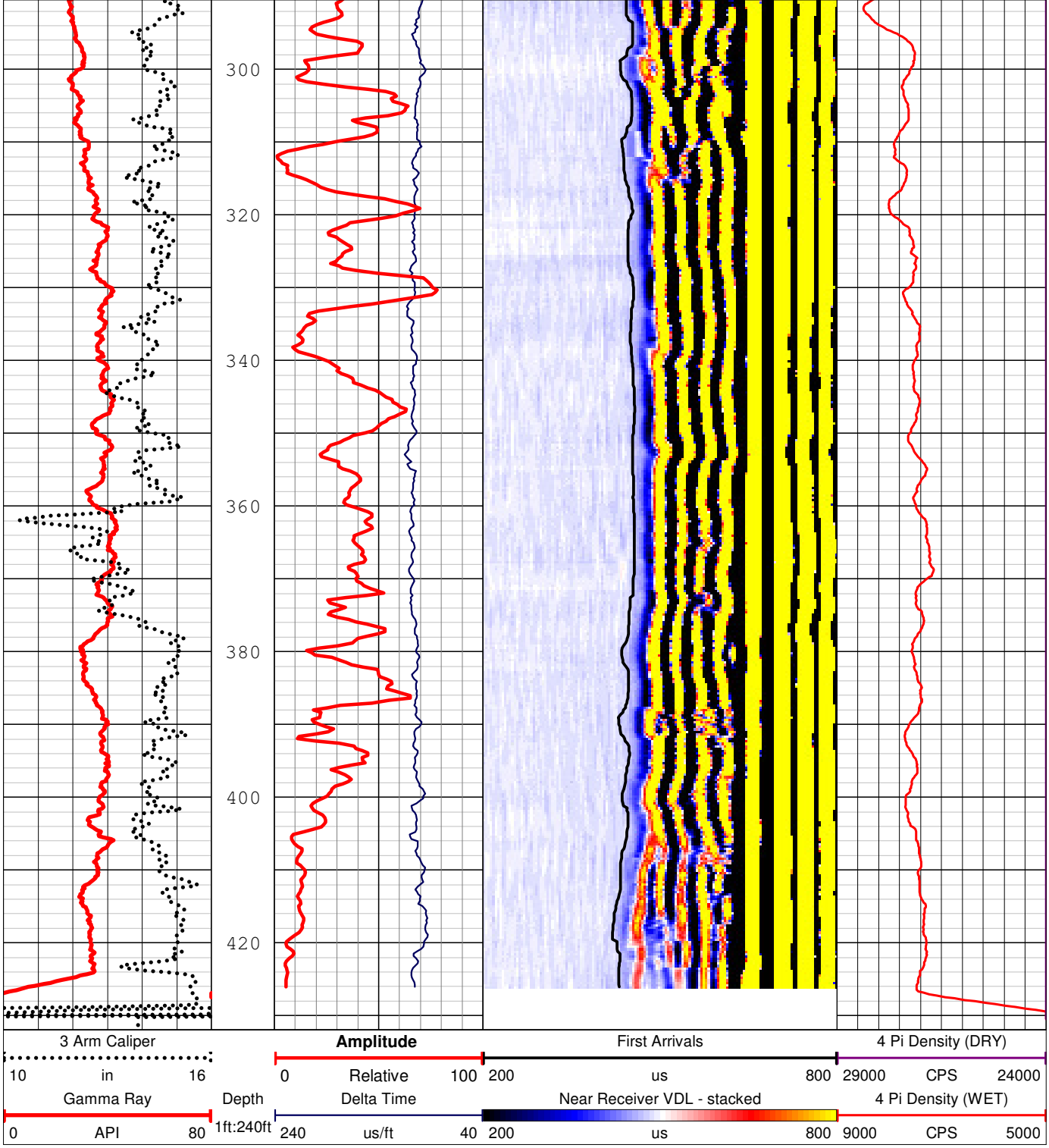
300
320
340
360
380
400
420
3 Arm Caliper
10 in 16
Gamma Ray
0 API 80
Depth
1ft:240ft
Amplitude
0 Relative 100
Delta Time
240 us/ft 40
First Arrivals
200 us 800
Near Receiver VDL - stacked
200 us 800
4 Pi Density (DRY)
29000 CPS 24000
4 Pi Density (WET)
9000 CPS 5000

3.0 San Andres Ground-Water Quality

Monitoring of San Andres ground-water quality in the Grants project area is being used to determine if any of the San Andres wells currently used to supply fresh water for the ground-water restoration program have exhibited a change in casing integrity that is reflected in water quality changes. Additional monitoring of the four San Andres wells that HMC uses to supply fresh water has been done in 2015. This data will be tabulated in the Annual Performance report, but for convenience, updated water quality plots are presented in this report for the evaluation of these wells.

3.1 Sulfate Concentrations

Sulfate is a major constituent that has been used to track water quality changes at the Grants Reclamation Project. Figure 3-1 presents an updated plot of the sulfate concentrations in San Andres wells 943, 951, 951R, #1 and #2. This plot has been presented in the Annual Performance report. Figure 3-1 shows sulfate concentrations for the first three quarters of 2015 for wells 943, 951R, #1 and #2, and reveals that these concentrations are consistent with the concentrations measured since 2000. There was no measurable change in sulfate concentration in 2015, and this is indicative of no change in the well integrity for any of these four San Andres supply wells in 2015.

Figure 3-2 presents the plot of sulfate for irrigation supply wells 806R and 938 and two of the Milan supply wells (wells 532 and 999). The 2015 sulfate concentrations are not available for these wells but the annual sample for wells 532 and 999 were collected on September 30, 2015.

3.2 TDS Concentrations

TDS is also a major parameter that has been used to track water quality changes at the Grants project. Figure 3-3 presents a plot of the TDS concentrations in San Andres wells 943, 951, 951R, #1 and #2. This plot shows that the 2015 TDS concentrations are very similar to previous values for wells 943, 951R, #1 and #2. This plot does not indicate any change in the well integrity for any of these four San Andres supply wells in 2015.

Figure 3-4 presents the plot of sulfate for irrigation supply wells 806R and 938 and Milan supply wells 532 and 999. The 2015 TDS concentrations are not available yet for these wells.

3.3 Chloride Concentrations

Chloride is a major constituent that typically moves very conservatively and has been used to track water quality changes at the Grants Reclamation Project. Figure 3-5 presents a plot of the chloride concentrations in San Andres wells 943, 951, 951R, #1 and #2. This plot shows that the 2015 chloride concentrations are very similar to previous values for wells 943, 951R, #1 and #2. This plot does not indicate any change in the well integrity for any of these four San Andres supply wells in 2015.

Figure 3-6 presents the plot of chloride for irrigation supply wells 806R and 938 and Milan supply wells 532 and 999. The 2015 chloride concentrations are not available yet for these wells.

3.4 Uranium Concentrations

Uranium is a minor constituent that is very important relative to ground-water restoration at the Grants project. Figure 3-7 presents a plot of the uranium concentrations in San Andres wells 943, 951, 951R, #1 and #2. This plot shows that the first three quarters of 2015 uranium concentrations are very similar to previous values for wells 943, 951R, #1 and #2 except for the decline in uranium that was observed in well 951R in the first half of 2015. The increase in uranium concentration in well 951R that was observed in 2014 prior to the 2015 decline is not thought to be a function of changes in well integrity in 951R, but is attributed to changes in the San Andres aquifer water quality in this area. Well 951R was drilled in 2012 and cemented from the inside of the casing back up the annulus to the land surface. This type of completion should result in a good bond between the casing and cement in the well annulus. Well 951R is scheduled to be logged and videoed in the first quarter of 2016. This plot does not indicate any change in the well integrity for any of the other three San Andres supply wells in 2015.

Figure 3-8 presents the plot of uranium for irrigation supply wells 806R and 938 and two of Milan supply wells 532 and 999. The 2015 uranium concentrations are not available yet for these wells.

3.5 Selenium Concentrations

Selenium is also a minor constituent that is very important relative to ground-water restoration at the Grants project. Figure 3-9 presents a plot of the selenium concentrations in San Andres wells 943, 951, 951R, #1 and #2. This plot shows that the first three 2015 selenium concentrations are very similar to previous values for wells 943, 951R, #1 and #2. This plot does not indicate any change in the well integrity for any of these four San Andres supply wells in 2015.

Figure 3-10 presents the plot of selenium for irrigation supply wells 806R and 938 and two of Milan supply wells 532 and 999. The 2015 selenium concentrations are not available yet for these wells.

Figure 3-1

Sulfate Concentrations for San Andres Wells 943, 951, 951R, #1 Deep Well, and #2 Deep Well

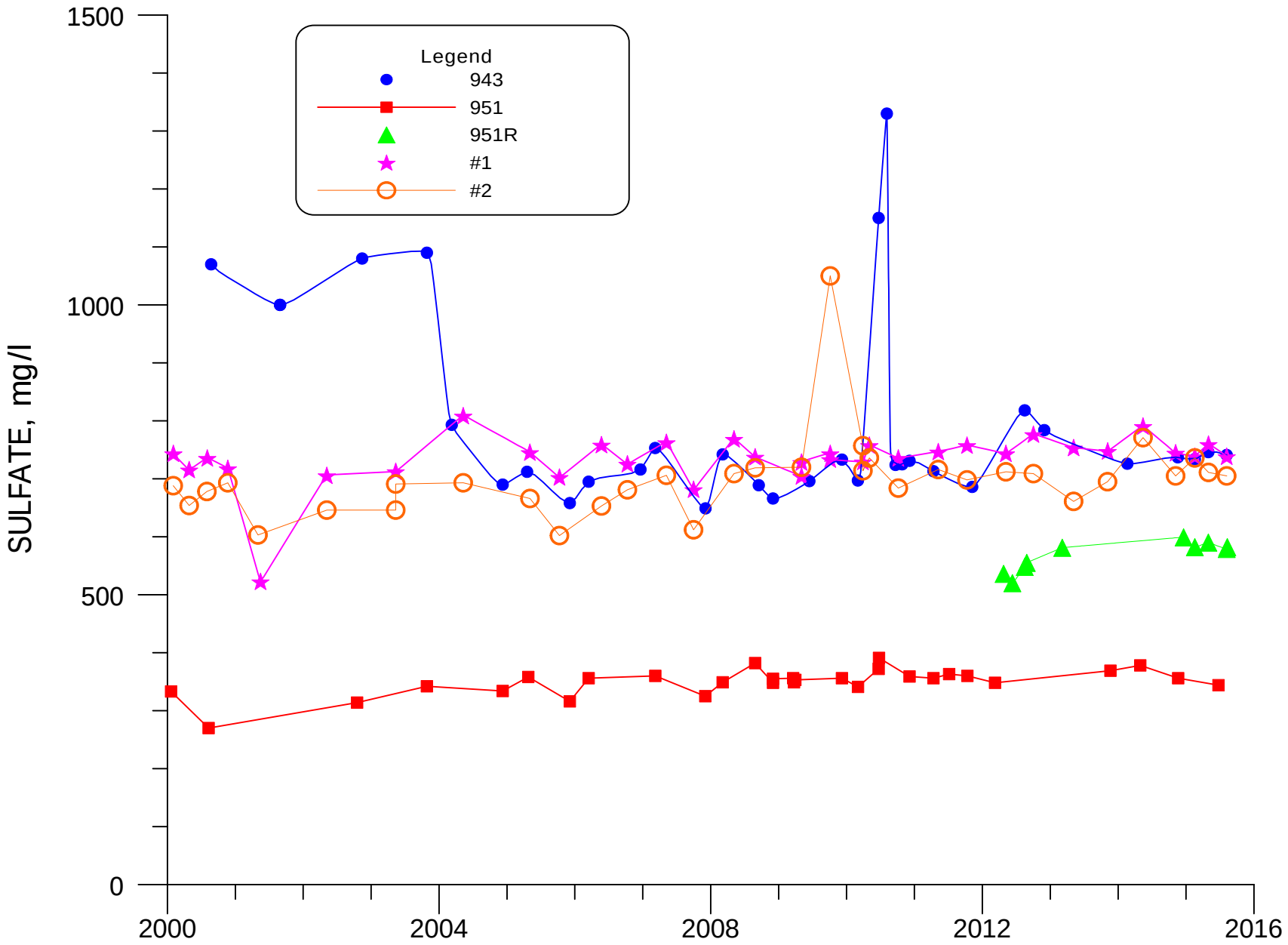

FIGURE 3-1. SULFATE CONCENTRATIONS FOR SAN ANDRES WELLS 943, 951, 951R, #1 & #2.

Figure 3-2

Sulfate Concentrations for San Andres Wells 532, 806R, 938, and 999

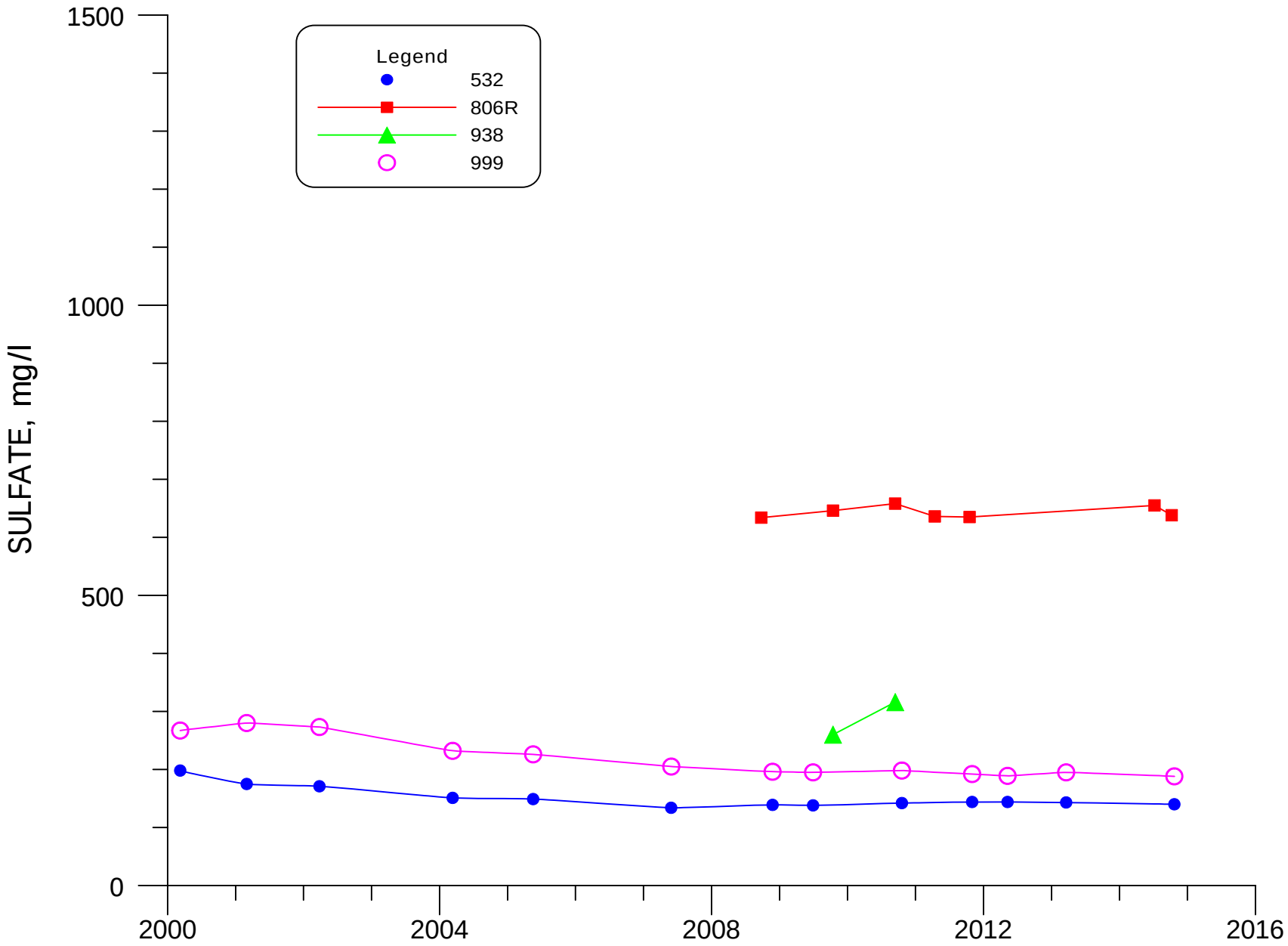

FIGURE 3-2. SULFATE CONCENTRATIONS FOR SAN ANDRES WELLS 532, 806R, 938 & 999.

Figure 3-3

TDS Concentrations for San Andres Wells 943, 951, 951R, #1 Deep Well, and #2 Deep Well

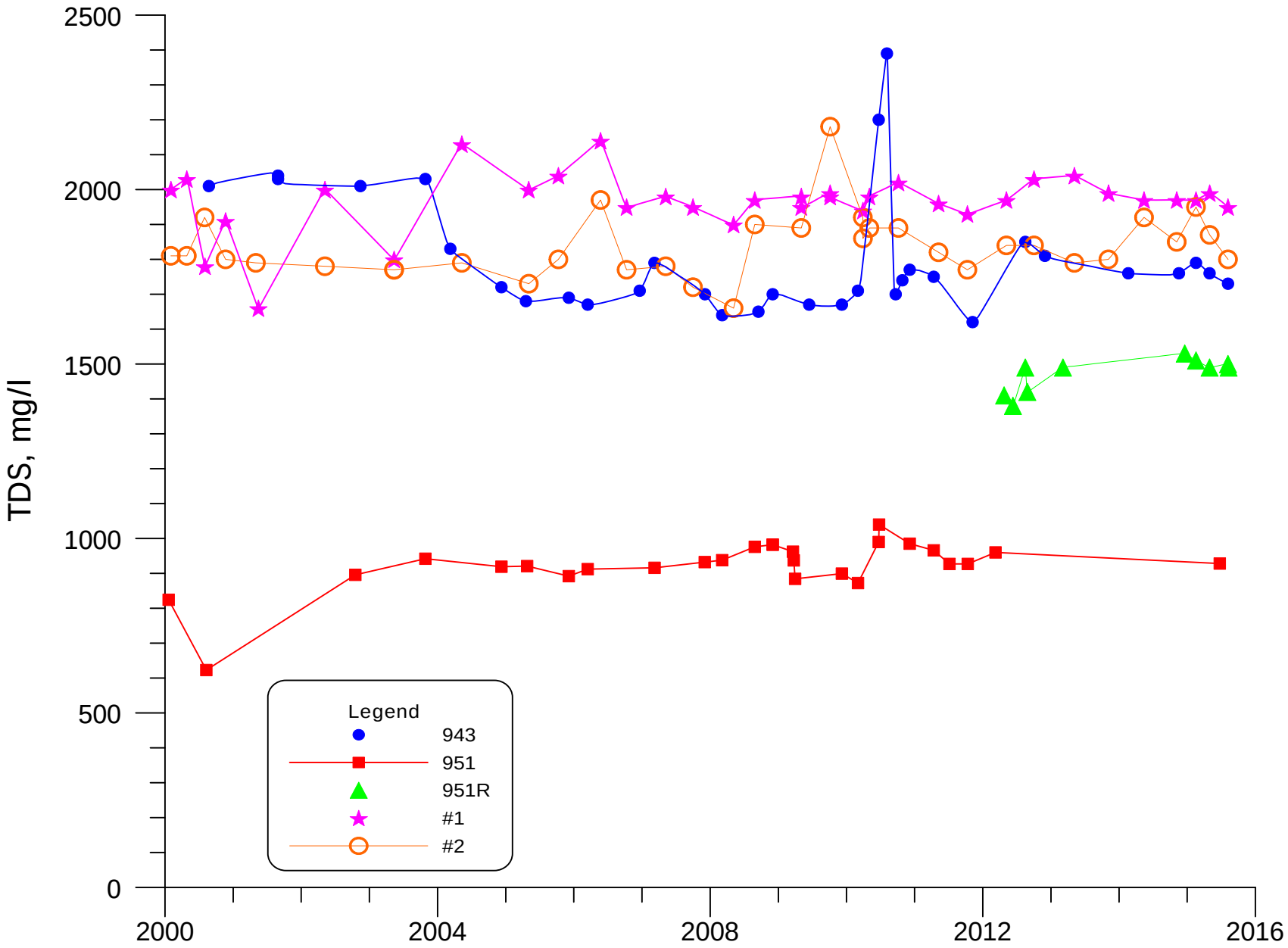

FIGURE 3-3. TDS CONCENTRATIONS FOR SAN ANDRES WELLS 943, 951, 951R, #1 & #2.

Figure 3-4

TDS Concentrations for San Andres Wells 532, 806R, 928, and 999

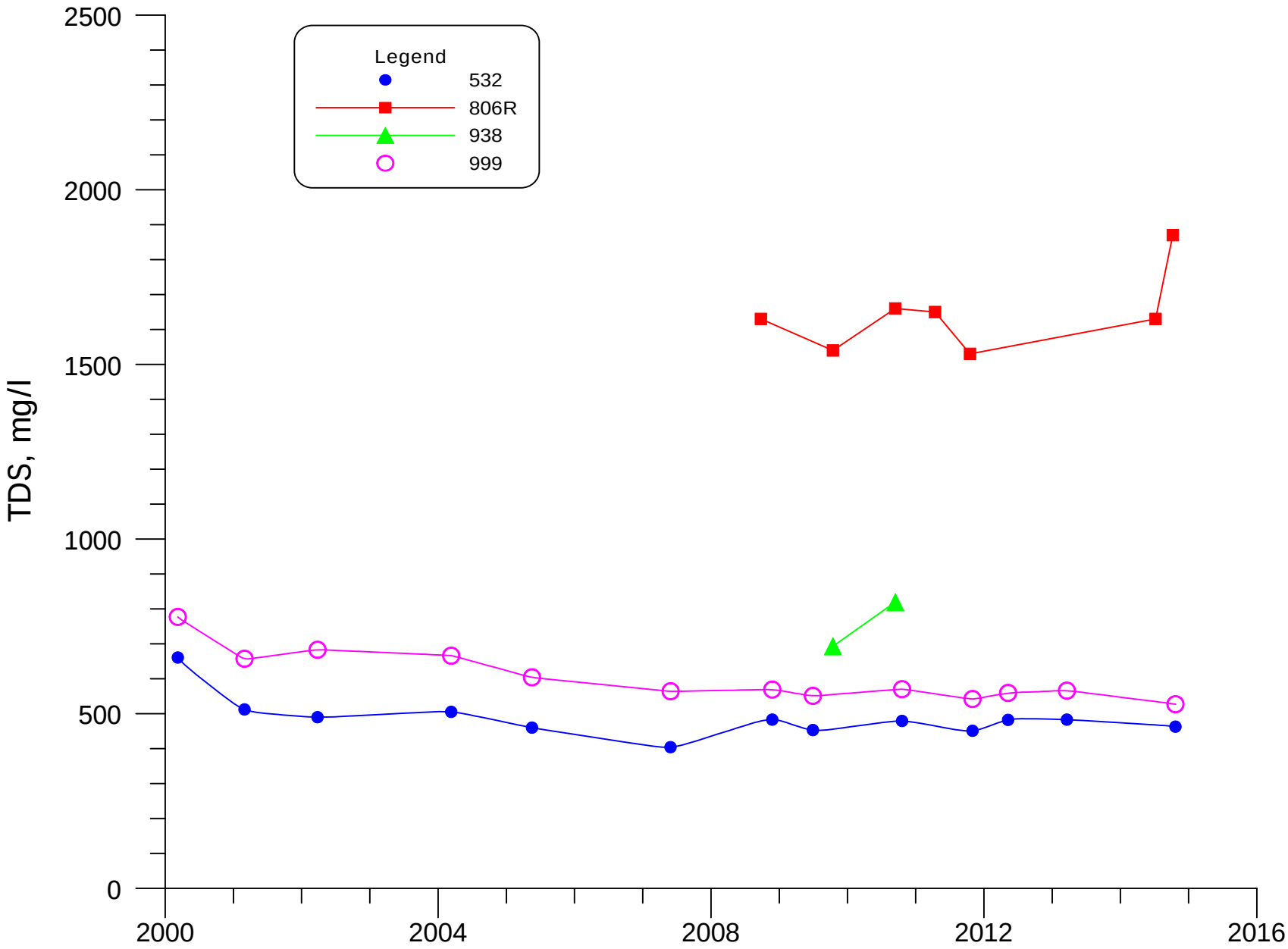

FIGURE 3-4. TDS CONCENTRATIONS FOR SAN ANDRES WELLS 532, 806R, 938 & 999.

Figure 3-5

Chloride Concentrations for San Andres Wells 943, 951, 951R, #1 Deep Well, and #2 Deep Well

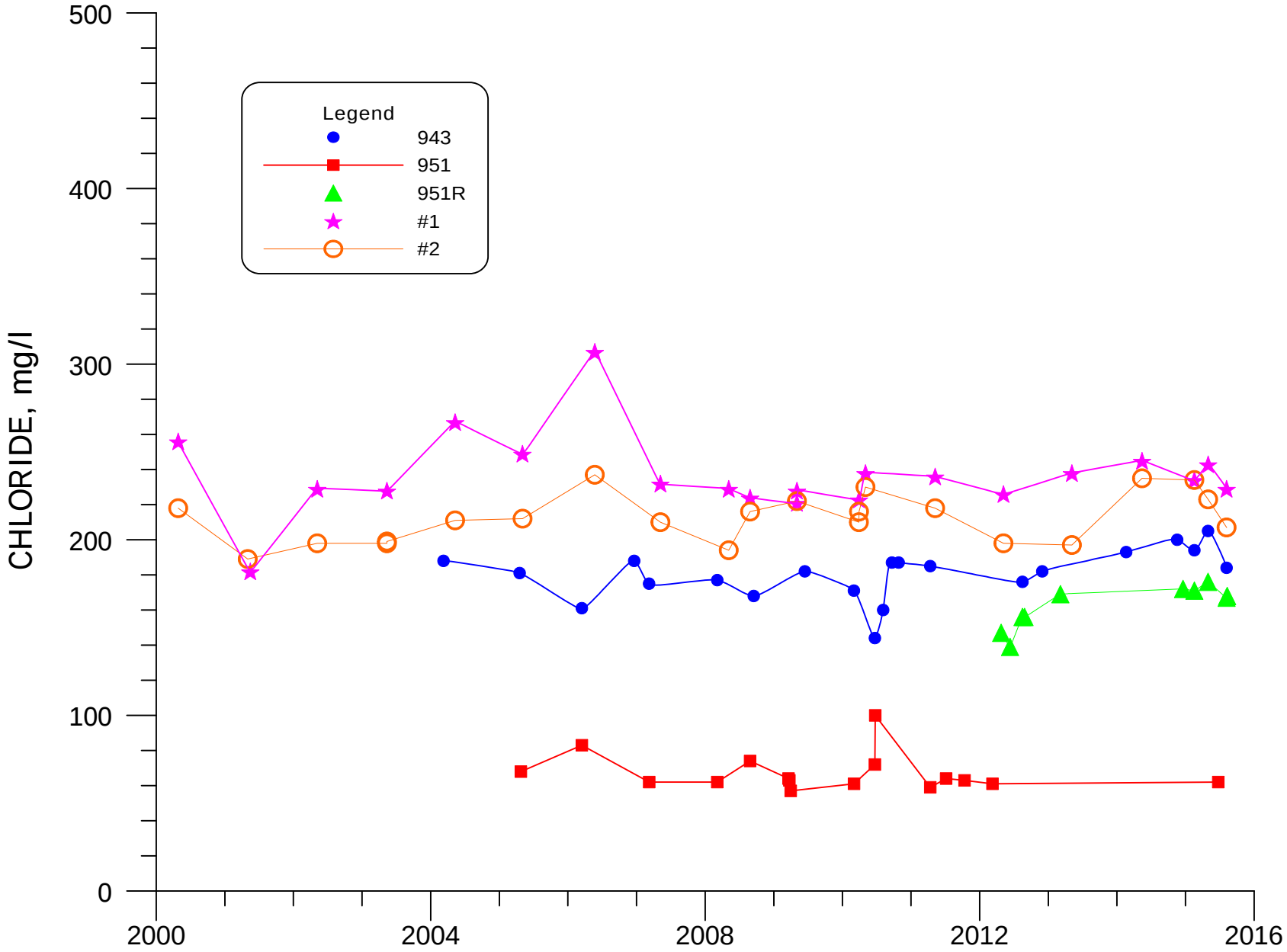

FIGURE 3-5. CHLORIDE CONCENTRATIONS FOR SAN ANDRES WELLS 943, 951, 951R, #1 & #2.

Figure 3-6

Chloride Concentrations for San Andres Wells 532, 806R, 938, and 999

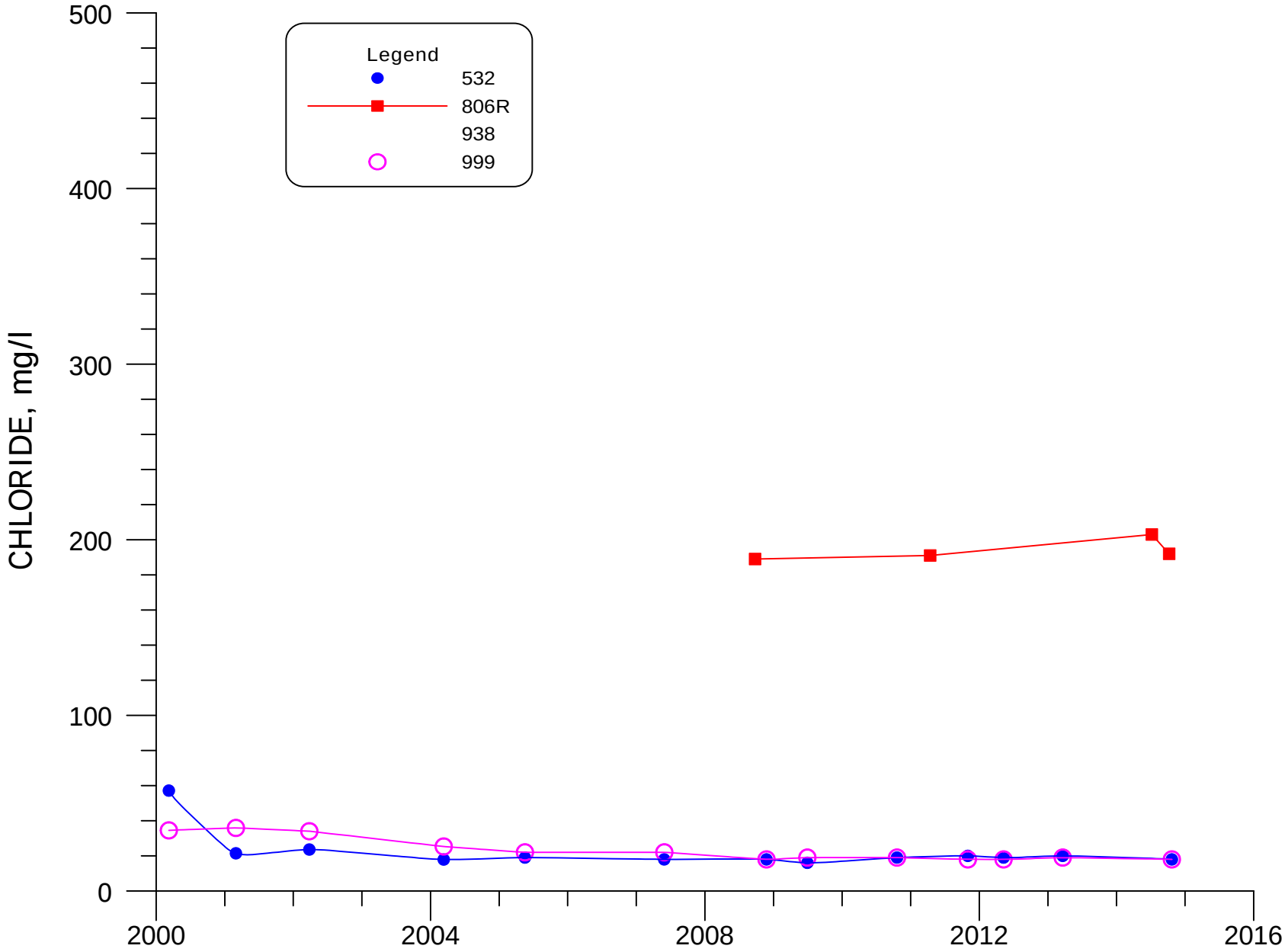

FIGURE 3-6. CHLORIDE CONCENTRATIONS FOR SAN ANDRES WELLS 532, 806R, 938 & 999.

Figure 3-7

Uranium Concentrations for San Andres Wells 943, 951, 951R, #1 Deep Well, and #2 Deep Well

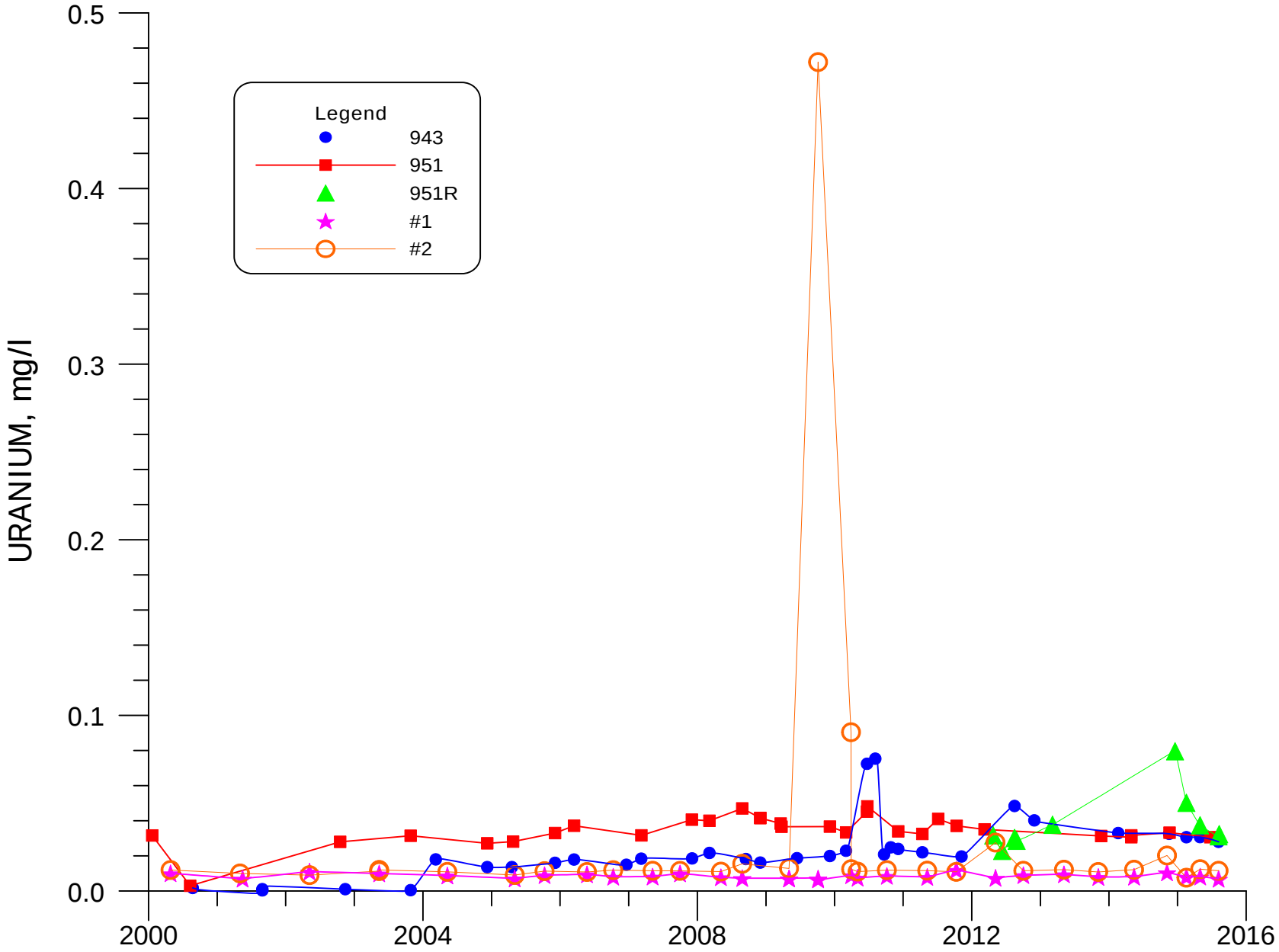

FIGURE 3-7. URANIUM CONCENTRATIONS FOR SAN ANDRES WELLS 943, 951, 951R, #1 & #2.

Figure 3-8

Uranium Concentrations for San Andres Wells 532, 806R, 938, and 999

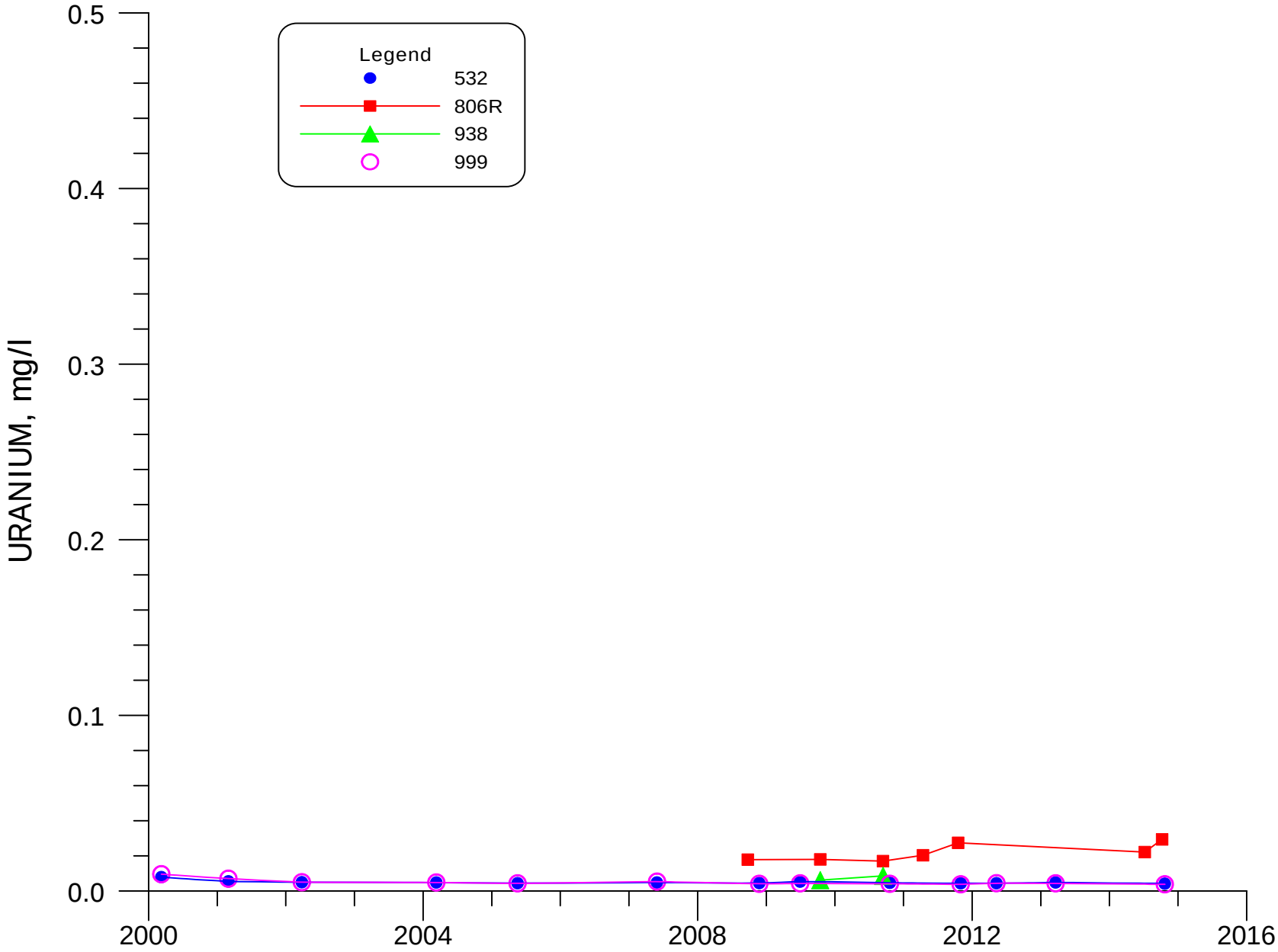

FIGURE 3-8. URANIUM CONCENTRATIONS FOR SAN ANDRES WELLS 532, 806R, 938 & 999.

Figure 3-9

Selenium Concentrations for San Andres Wells 943, 951, 951R, #1 Deep Well, and #2 Deep Well

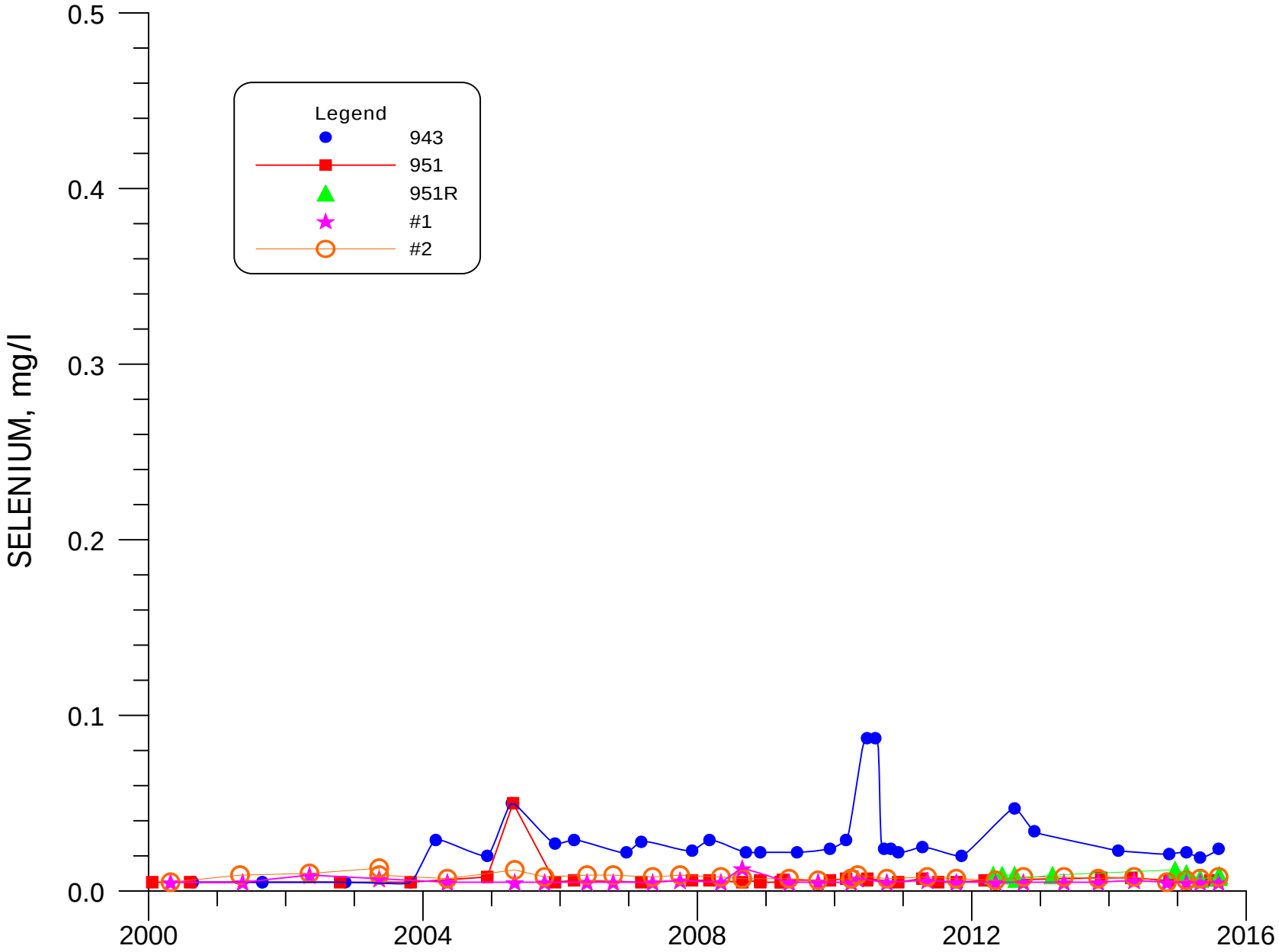

FIGURE 3-9. SELENIUM CONCENTRATIONS FOR SAN ANDRES WELLS 943, 951, 951R, #1 & #2.

Figure 3-10

Selenium Concentrations for San Andres 532, 806R, 938, 999

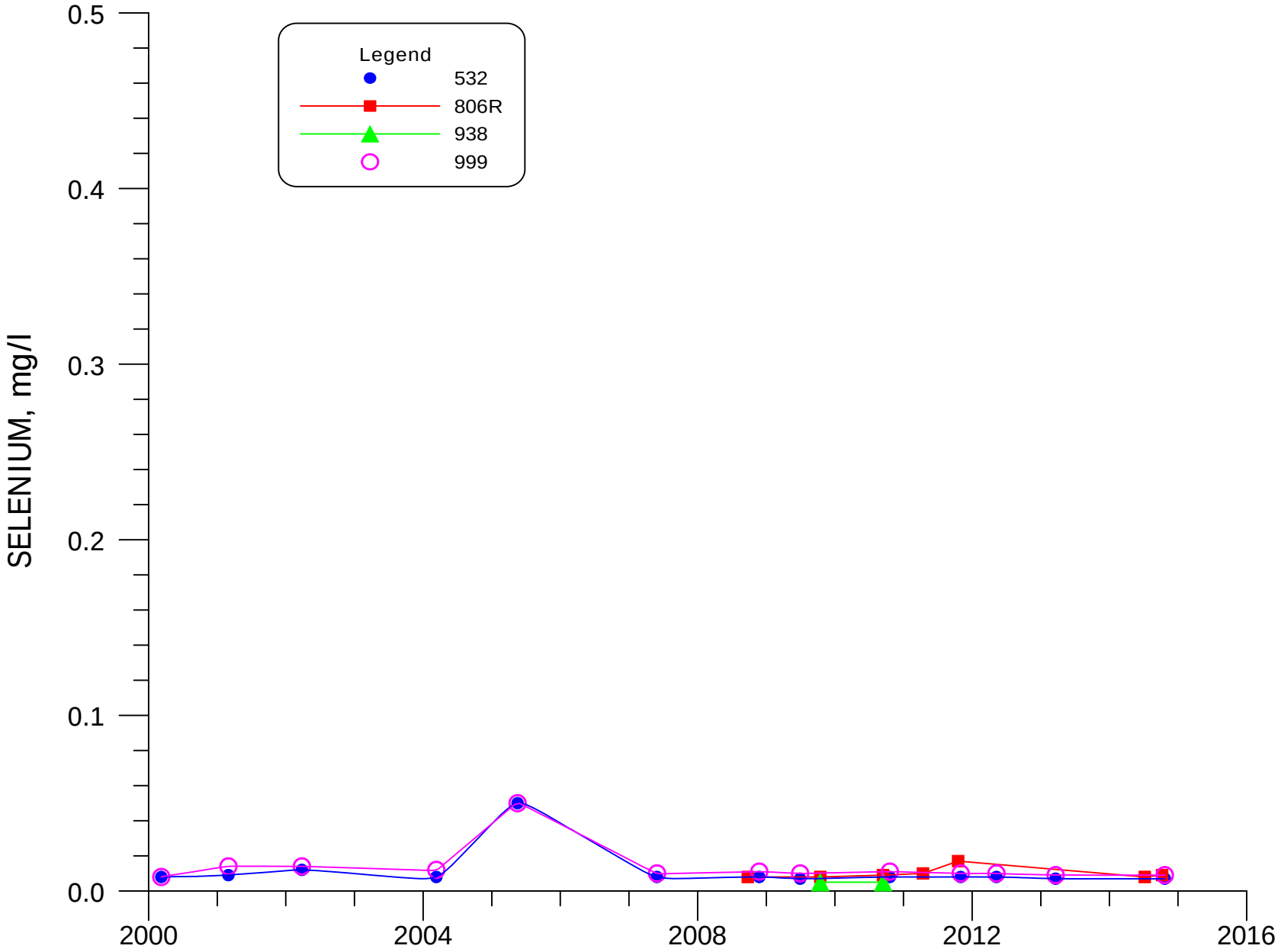

FIGURE 3-10. SELENIUM CONCENTRATIONS FOR SAN ANDRES WELLS 532, 806R, 938 & 999.

4.0 Conclusion

The San Andres well integrity testing for well 951 shows that the integrity of this well is good and the well can be used as a monitoring well for the San Andres aquifer. The testing of well 928 shows that the integrity of the casing in well 928 has been damaged, and an abandonment plan will be prepared for the NMOSE. However, the well completion data and the recent testing indicates that well 928 appears to be functioning as a Middle Chinle aquifer well, and is not believed to have a connection to the San Andres aquifer. Therefore, there the data suggests there is no concern for the condition of this well to adversely affect the San Andres aquifer. The testing of well Old #1 shows that the level in this well is representative of the alluvium, and that a plug may exist that seals off the San Andres in this well. Additional testing needs to be done to determine if a plug exists in Old #1 well to develop a final abandonment plan for this well.

The San Andres monitoring in 2015 does not indicate that the integrity of the existing San Andres supply wells #1, #2, 943 and 951R well has changed. These four San Andres wells can continue to be used as a fresh water supply. Well integrity testing for these four wells is planned for 2016.

5.0 References

Gordon, E.D., 1961, Geology and Ground-Water Resources of the Grants-Bluewater Area Valencia County, New Mexico with a section on aquifer characteristics by H.O. Reeder and a section on chemical quality of the ground water by J.L. Kunkler, New Mexico State Engineer Technical Report 20, 109pp.

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APPENDIX A

Video of Wells 951, 928 and Old #1
(see CD)